The Chemical Age

VOL LXII 25 FEBRUARY 1950 No 1598

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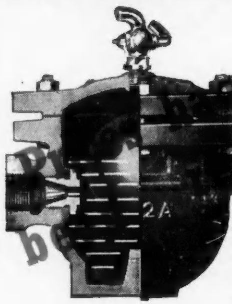

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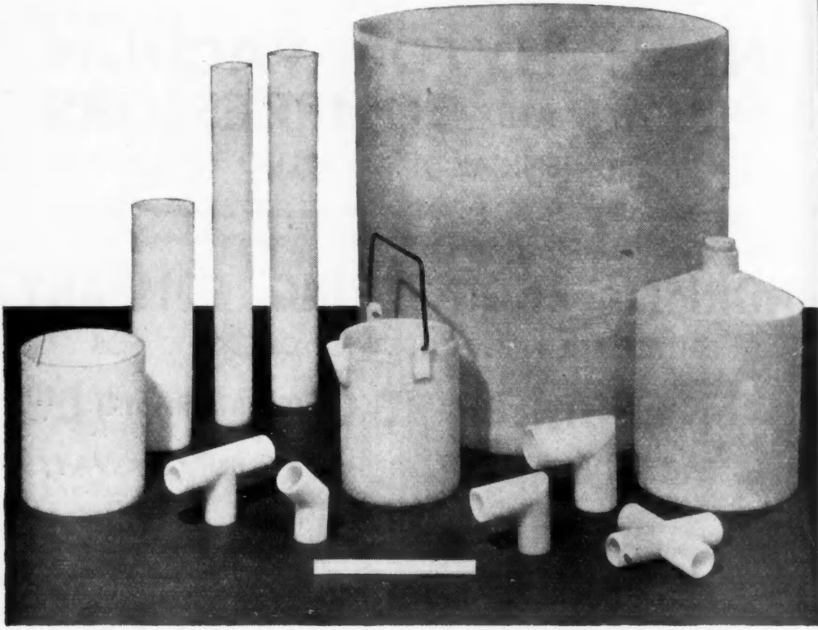

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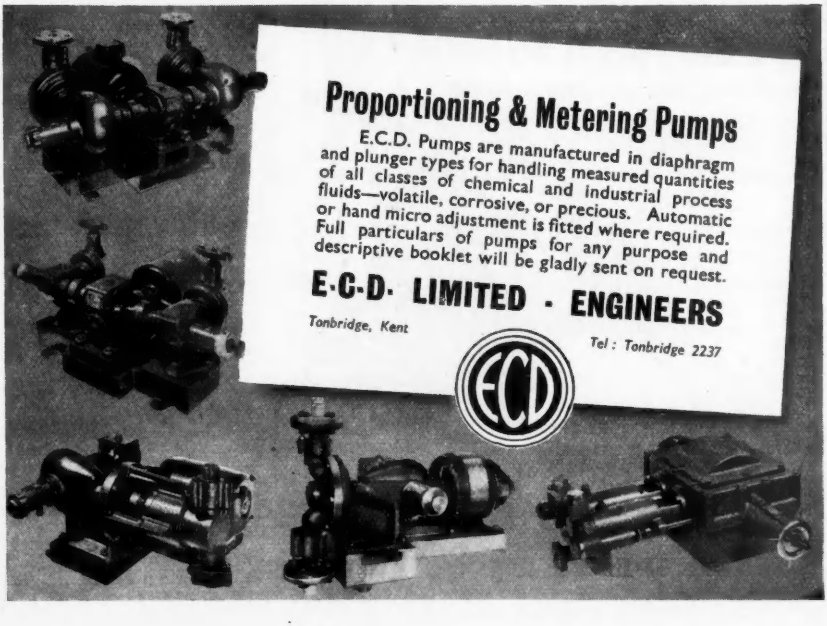
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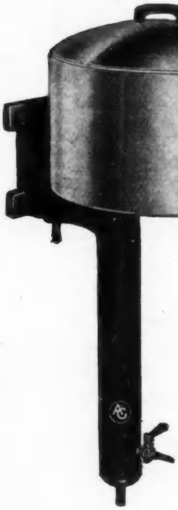

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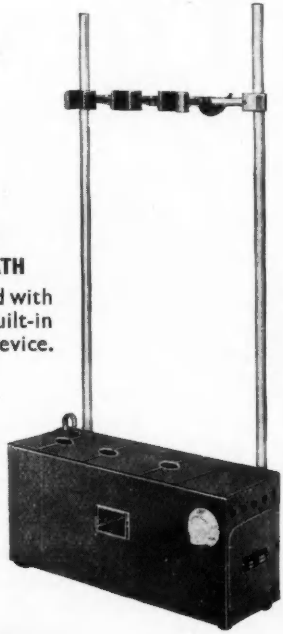

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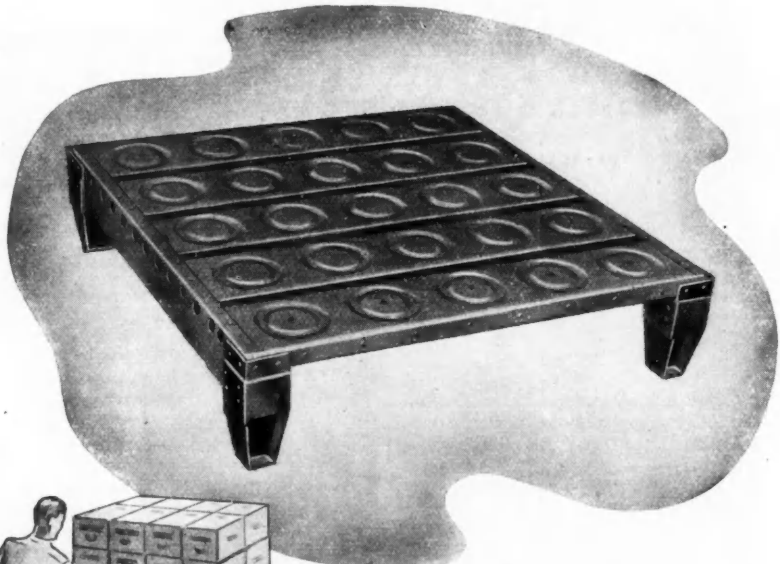

The
Chemical Age
The Weekly Journal of Chemical Engineering and Industrial Chemistry

BOUVERIE HOUSE 154 FLEET STREET LONDON E.C.4
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Volume LXII 25 February 1950 Number 1598

Atomic Power and Chemists

FOR reasons that have never been satisfactorily explained, little more than smatterings of information have been revealed in this country about the progress of atomic fission. The bomb and all that it represents has overshadowed the prospects of harnessed atomic energy. A lecture recently given by Dr. Hafstad, director of reactor development at the U.S. Atomic Energy Commission, to the American Institute of Chemical Engineers (*Chemical Industries*, **66**, 28-29) has lifted a corner of the uranium curtain. The prospect of atomic power is still remote and even if physicists succeed in developing atomic fuel reactors the practical and economic operation of these power units will depend upon chemists and chemical engineers.

One type of reactor being developed by the U.S. Atomic Energy Commission is what is known as a breeder reactor. The breeding conception has in it something like perpetual motion, for its aim is the production of more fissionable material than is initially consumed as fuel. Uranium has the two natural forms, U-238 and U-235, of which only the latter is fissionable. If excess neutrons from the fission of U-235 are captured by U-238, then U-238 can be converted into plutonium, which is fissionable. Converters operated so far have, unfortunately, produced smaller amounts of plutonium than the original amounts of U-235. The wastage of neutrons in practice conflicts with the theory that sufficient should be released from U-235 atoms to provide a "profit" in fissionable atom production. The possibility of breeding emerges from this idea, converting uranium-238—of which there is an adequate supply—into more and more plutonium. U-238, says Dr. Hafstad, is approximately 140 times more plentiful than U-235.

Developing such a breeding process is clearly a long-term assignment for atomic physicists. Their problem is to eliminate the wastage of neutrons in the conversion process. But even if they succeed, there will be a further wastage factor to be overcome—the reprocessing of the fuel elements themselves. This kind of "fire" also produces waste, which must be periodically removed to keep the fire going. These "ashes" are the chemical products of fission, radioactive elements close to barium in the periodic table. It is here that the chemist must make his contribution before atomic energy can be harnessed

On Other Pages

The annual subscription to THE CHEMICAL AGE is 30s.; single copies, 9d.; post paid, 1s. SCOTTISH OFFICE: 116 Hope Street, Glasgow (Central 3970). MIDLANDS OFFICE: Daimler House, Paradise Street, Birmingham Midland 0784-5). THE CHEMICAL AGE offices are closed on Saturdays in accordance with the adoption of the five-day week by Benn Brothers, Limited

for peaceful power. The fuel elements have to be withdrawn from the reactor, chemically cleaned, remade, and replaced. This represents as large an economic factor of loss as the present U-235 neutron wastage in conversion of U-238 into plutonium. In Dr. Hafstad's own words: "It pains me to see carefully fabricated and machined parts, products of many hours of highly skilled work, casually dissolved in acid to start the chemical purification."

Chemical engineers have already put forward entirely new ideas. They have suggested that the present design of reactors, with their fuel elements embedded in other cooling and protective materials, might be constructed homogeneously, with the fuel elements placed in solutions or even surrounded by modern fluidised solids. Design of this nature would help to eliminate the costly and cumbersome fuel element removal and purification. Dr. Hafstad made it clear that this type of reactor, though at present no more than a blue-print speculation, will characterise an important section of future American research. Meanwhile four reactors of the heterogeneous type are under construction, and it is significant that most progress has been made in building an experimental "fast breeder" at the Reactor Testing Station in Idaho. Although these types of reactor present such serious cleaning problems, it may reasonably be expected that experience gained from their pilot operation will provide a starting point for the construction of homogeneous reactors.

To those of us who must stand outside this new and secret branch of science and who can rely only upon occasional glimpses of progress in forming our opinions one thing seems abundantly clear. It must be many years before man's power to split the atom can be converted into controllable industrial power at an economic cost. Here, indeed, is the very substance of difference between war and peace. War is an uneconomic venture, and only when cost was disregarded amid the atmosphere of world war was it possible to develop U-235 into an atomic bomb. Huge processing wastages had no other comparative background save those other wastages of war which the unilateral possession of the same weapons might eliminate. How very different is the project of turning U-235 into a final

(*continued on page* 286)

Notes and Comments

Overseas Trade Trends

THE capacity of chemical industries to handle and negative most of the possibly disturbing effects of a change as fundamental as the devaluation of the £ is attested by the summaries of chemical import and export trading in the first month of the year. The new exchange rates have necessarily substantially raised values of some essential imports, such as sulphur and carbon black from the U.S.A., and occasionally rendered our export prices more competitive. Yet the swing in import and export totals in January was less marked than was thought likely when devaluation was first effected. Imports of the main categories of chemicals, drugs, dyes and colours (excluding sulphur) cost £2.6 million compared with £2.17 million in January a year ago; exports showed a relatively small reduction (some £278,000) in the total of £7,934,581. Of greater importance, in its conspicuous effect on the export picture, is the acute curtailment of chemical sales to India. These, in January last year, produced £1.47 million. Their total last month is recorded as £223,495. Far less disturbance has, of course, occurred in our smaller trade with Pakistan. The loss of Indian trade, should it prove to be irrecoverable, cannot fail to render remote the prospect of reaching the £9 million monthly export target formerly suggested for chemical industries.

Chemical Work at Harwell

THE long-standing criticism that chemical industry is prone to carry secretiveness to exaggerated lengths whether there is good reason for concealment or none has found another target in the Atomic Energy Research Establishment, the subject last week of a Press information note which was more provocative than revealing. The possibility that the larger pile at Harwell—whose operation during its first 12 months was dealt with—may already have revealed means of producing in materials chemical and physical changes of profound scientific and industrial interest is suggested, but in the absence of even elementary data the importance of this must be left to conjecture. "Many chemical reactions," says the Ministry of Supply, can be induced by nuclear radiations, of which BEPO provides an enormous source. Reactions which normally occur only at the highest temperatures obtainable in a furnace sometimes take place at ordinary temperatures inside the pile." That alone gives rise to a dozen questions—to which, it need hardly be said, there will be no answer at this stage, unless the more liberal policy by the American AEC should happen to provide it. It is not to be supposed, however, that the method of producing these fundamental changes within the pile has been reduced to a science. The brief information from Harwell does reveal that there is uncertainty there as to the source of particular chemical effects occurring in the presence of mixed radiation of neutrons and gamma rays. Some of the work with the large pile is now directed to distinguishing these effects, presumably with the view to their controlled application—one day.

Adventure in the Laboratory

MUCH has been written and spoken about the application of scientific knowledge to industry, but it was refreshing to hear Sir Ben Lockspeiser emphasise an aspect of the matter which has tended to be overlooked amid the preoccupation with finance, administration and the like. The secretary of the DSIR, opening the new laboratories of the British Non-Ferrous Metals Research Association last week, said: "We must never lose sight of the necessity to maintain our scientific capital. Science also has its gold reserves, and if they fall too low, technology loses the source of its sustenance. Every good laboratory

must keep a workable balance between the effort it gives to the getting of new knowledge and that it gives to applying what we know." Sir Ben went on to point out that the spirit of courage and good judgment in science could often produce startling results. A spirit of adventure and eagerness—even to the extent of breaking rules occasionally—was one of the distinguishing characteristics of a flourishing laboratory. Here indeed is the key to successful investigation, for without personal initiative, quick decisions and an ability to see great results from small beginnings, scientific research would cease to attract the great wealth, of men and money, which it still commands, more especially in its industrial divisions.

Aluminium Parade

ALUMINIUM'S emergence from the war-time category of materials reserved for strategic purposes only has been celebrated by increasing uses, some of which now seem to verge on prodigality. That is the first impression derived from the knowledge that aluminium is the chosen constructional material for two of the large forthcoming exhibitions in London—for the vast Dome of Discovery which is to house much of the review of science in industry at the Festival of Britain, and more immediately as the main structural feature of this year's Ideal Homes Exhibition. Aluminium will be very much to the fore at the Olympia exhibition, in the form of an arch 75 ft. high and 100 ft. wide at the base, linked with avenues and pavilions spanned with aluminium tracery. It is believed that the arch alone will require about 12 tons of aluminium alloys, sufficient to supply for a considerable time one or other of the innumerable industrial uses of aluminium. The apparent prodigality will be compensated, from the point of view of aluminium producers, by the spectacular publicity for the metal, for the dome and the arch will be larger than anything of the kind attempted outside the aeronautical field. The company supplying the Ideal Homes spectacle are reassuring on the point. When the exhibition closes, they say, about 50 per cent of the metal will be capable of re-erection when similar need arises. The other half will be recovered as salvage and, after reprocessing, may find its way back to industry, where in view of the steadily expanding uses it seems more properly to belong.

ATOMIC POWER AND CHEMISTS

(*continued from page 284*)

source of power to compete with coal, oil, or hydro-electricity.

Nevertheless, there is some perverse consolation in the fact that the post-war atomic arms race is not fast or easy. In the present state of man as a political animal, the Gargantuan costs of atomic development may be in effect a safety device. Mankind may find one day that it cannot afford to blow itself to pieces. To point this lesson, radioactive isotopes, by-products principally of the nuclear reactors, which are already serving science and technology, are cheap. Confidence that they may begin to make their contribution in the British industrial field has now been attested by the formation of at least one company to promote their fuller use.

C.A. Issues Sought

THE City of Johannesburg public library authorities are urgently seeking to acquire, as a gift or by purchase, a number of past issues of THE CHEMICAL AGE which are missing from their file and are now out of print. The South African library has asked THE CHEMICAL AGE to invite the collaboration of its readers who may have duplicate or unwanted copies. The issues required are these:—

Vol. 4: Nos. 81, 84, 87, 88, 91, 92, 93, 95, 96, 98, 99, 100 (1921).
Vol. 7: No. 167 and index (1922).
Vol. 8: Nos. 186, 192 and index (1923).
Vol. 9: Index (1923).
Vol. 10: No. 263 and index (1924).
Vol. 11: Nos. 265, 266, 267, 268, 278 and index (1924).
Vol. 12: No. 290, 311 and index (1925).
Vol. 13: Complete and index (1925).
Vol. 44: No. 1126 (1941).
Vol. 45: Nos. 1167, 1168, 1169, 1170 (1941).
Vol. 46: Nos. 1180, 1182, 1199 and index (1942).
Vol. 47: No. 1220 (1942).
Vol. 51: No. 1312 (1944).

BRITAIN'S LARGEST ATOMIC PILE

Only Four per cent of Radioisotopes for Industry

PASSING references to some of the important effects being produced developing the uses of Britain's largest atomic pile, BEPO, are made in the latest information issued by the Ministry of Supply. It briefly summarises the first year's work with the second pile at Harwell. (BEPO started up on July 3, 1948.) The next few months, records the Ministry, were spent on initial tests, and production of radioisotopes began and Feb. 28, 1949.

The report shows that in November last year the large pile produced 338 samples of radioisotopes (the elements are not mentioned) which were distributed and used in these proportions: medical uses 173, universities 30, industry 13; air deliveries overseas 57; internal use at AERE 65. Industry thus employed less than four per cent of the total.

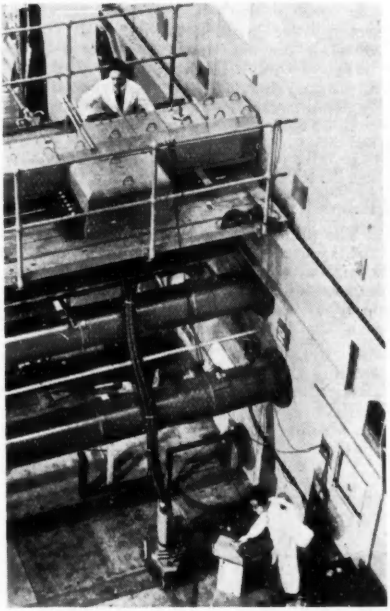
Improved Uranium Cartridge

Experience during the first year is said to have enabled the metallurgy and engineering divisions to develop an improved uranium cartridge, cased in aluminium, which can resist a higher temperature than those at present in use. It is anticipated that when the improved cartridges are loaded into the pile it will be possible to increase considerably the energy available in the pile, and so extend the scope of experimental work.

BEPO is being used for three main purposes: the production of radioisotopes; studies of the effects of neutrons and gamma rays on materials; and experiments in nuclear physics and neutron diffraction.

One of the most interesting passages in the short report by the Ministry relates to physical and chemical changes in materials effected by irradiation within the pile in which there are 40 holes made to receive experimental specimens. Many chemical reactions, it is noted, can be induced by nuclear radiations, of which BEPO provides an enormous source. Reactions which normally occur only at the highest temperatures obtainable in a furnace sometimes take place at ordinary temperatures inside the pile.

The report gives no indication of the materials in which such chemical changes have been induced, and it refers to the uncertainty existing as to the source of these effects, because the pile sets up a complex of neutrons and gamma rays of varying proportions and energies. Some of the chemical investigations at Harwell are to distinguish these effects and to determine the results of varying the energy and intensity of the rays.



Through the lead tunnel, mounted on the platform, come the irradiated materials from the pile, one face of which is shown here. The radioactive isotopes in their aluminium cans are ejected from the tunnel by plungers (near the operator's right hand) and fall down the sheathed tubes into the shielded mobile container below. In the large horizontal tubes are the cadmium control rods regulating the intensity of the chain reaction

For most of this work, states the Ministry, a narrow beam of neutrons is allowed to escape from the centre of the pile through a small hole in the concrete and steel shield. These beams are used to study the precise characteristics of various nuclear reactions, such as the process of fission itself.

ISOTOPES IN INDUSTRY

Commercial Developments

THE Ministry of Supply has co-operated in the selection from the Atomic Energy Research Establishment, Harwell, of staff for the newly incorporated company, Isotope Developments, Ltd. (THE CHEMICAL AGE, 62, 244), believed to be the first commercial firm to act as consultants and suppliers of radioactive isotopes for industry and agriculture.

The technical staff is headed by Mr. K. Fearnside, and the chairman is Mr. R. D. Peters.

The following are practical examples of the type of problems of interest to the chemical and associated industries which can be solved by the application of radioisotopes and with which the new company will concern itself.

A Beta gauge for measuring and controlling the basis weight of sheet material, particularly plastics; the measurement and control of the thickness of coating applied to a metal, as for example, chromium plating on steel; determination of impurities in compounds more accurately than is possible by spectrographic means, when the impurities are present in extremely small quantities, as for example, arsenic in germanium.

Determination of losses of valuable constituents in normal working processes; and the elimination of static electricity from handling processes involving dry material, as for example, explosive substances or plastic sheet.

SHELL HAVEN REFINERY

Large-Scale Petroleum Engineering

CONSTRUCTIONAL work on the Shell Haven refinery, near Southend, Essex, is reported to be progressing at a rate which should ensure its readiness to start to operate in November, 1950.

A tunnel, 9 ft. in diameter, is being built 50 ft. below the Thames. Extending 900 ft., it will carry cooling water from the river to the refinery site. Miners, working 8-hour shifts, are moving forward at the rate of about 100 ft. a month.

A water pumphouse, 250 ft. by 50 ft., with the main pump units assembled 30 ft. below ground level, will service the process area with the cooling water. Eventually, units will be installed to deliver water at the rate of at least 80,000 g.p.m.

The Shell Haven and Stanlow refineries will together handle more than 6 million tons of crude oil yearly to produce a complete range of finished petroleum products. The labour force at Shell Haven, now 2200 strong, will eventually be increased to 3000.

The first distillation plant will be commissioned to process a planned intake of 6000 tons a day of crude oil. Notable features of this plant include a high degree of control by instrumentation and the almost complete elimination of steam for operating pumping units, most of which will be electrically driven.

A reforming unit, to process some 1200 tons of naphtha a day, is due to be in full operation by May, 1951.

Thirty-four New Associates of the RIC

NEW Associateships of the Royal Institute of Chemistry have been announced as follows in the Pass List for the January examinations:

BENSON, Gerald Bernard, B.Sc.(Lond.), South-East Essex Technical College, Dagenham; CASAJUANA, Brian Eric, B.Sc. (Lond.), Nottingham and District Technical College; CORDES, Miss Elsa Mary, B.Sc.(Lond.), Northern Polytechnic, London; DAVIES, Glyn, B.Sc. (Lond.), College of Technology, Manchester, and Royal Technical College, Salford; FAIRWEATHER, John Henry, Technical College, Cardiff; FEATHERSTONE, Arthur Andrew Valentine, Municipal Technical College, Widnes; FITCH, George Roy, B.Sc.(Lond.), Wolverhampton and Staffordshire Technical College, Wolverhampton; FOGDEN, Eric Reginald William, Municipal College, Portsmouth; FOXLEY, Donald, City College of Technology, Liverpool; HOCKEY, Cyril Victor, Chelsea Polytechnic, London, and Technical College, Huddersfield; HOCKINGS, Eric Francis, Technical College, Brighton; HUDSON, Harry Robinson, Municipal Technical College, Hull; JONAS, Donald Moore, KIN, Leslie, and LAND, John Robert, City College of Technology, Liverpool; MACDERMOTT, Philip Eric, B.Sc.(Lond.), Royal Technical College, Salford; MALIN, Leonard, B.Sc.(Lond.), Municipal Technical College, Hull; MATHER, Eric, College of Technology, Manchester, and Royal Technical College, Salford; MILMAN, Francis Leonard, City College of Technology, Liverpool; MORRIS, Neville John, Royal Technical College, Salford; MOVERLEY, Stuart, Municipal Technical College, Hull; NEWTON, Rex James, The Polytechnic, Regent Street, London; PHILLIPS, James Ivor, and PHILLIPS, Kenneth Albert, City College of Technology, Liverpool; REYNOLDS, George Frederick, B.Sc.(Lond.), Medway Technical College, Gillingham; RICHARDS, Maurice George, Municipal College, Portsmouth; RUSSELL, Harold James, B.Sc.(Lond.), South-East Essex Technical College, Dagenham; SILVER, Derrick John, Denbighshire Technical College, Wrexham, and South-West Essex Technical College, Walthamstow; SOUTHGATE, Norman Arthur, B.Sc.(Lond.), Woolwich Polytechnic, London; STRIPE, James Thomas Stanley, Northern Polytechnic, London; TAYLOR, Miss Muriel Margaret, Morecambe and Lancaster Technical College, Lancaster; THOMAS, David Henry, College of Technology, Manchester, and Wigan and District Mining and Technical College; TINDALE, Leslie, Municipal Technical College, Hull; WILLIAMS, Edward, B.Sc.(Lond.), City College of Technology, Liverpool.

OVERSEAS TRADE TOTALS

Chemical Exports Nearly £8m.

EXPORTS of chemicals, drugs, dyes and colours in January reached a total value of £7,934,581 compared with £8,212,770 in the same month of 1949, and £6,756,587 in 1948. The totals of various groups showed increases over the previous month. Some characteristic increases were these (December, 1948, figures in brackets): chemical manufactures (excluding drugs and dyestuffs) £4,308,214 (£3,888,325); drugs and medicines £1,756,256 (£1,587,859); dyes and dyestuffs £746,899 (£644,471); paints and pigments £1,123,212 (£921,194).

After a reduction in the first month of last year, compared with the same period of 1948, the value of imports of all chemicals, drugs, dyes and colours in January was again higher. Comparative figures were: £2,609,934 (1950); £2,175,503 (1949) and £2,252,087 (1948). In addition, 32,285 tons of sulphur from the U.S.A. accounted for £307,176.

Gas and chemical machinery imports during the month were more than four times greater than 1949 and represented a total value of £95,112 compared with £22,965.

Details of export and import figures from the *Trade and Navigation Accounts of the United Kingdom*, January, 1950 (HMSO, 6s. 6d.) from which the figures above are abstracted, will appear in our next issue.

Fertiliser Expansion Plans

"THE greatest programme of expansion and modernisation ever undertaken by the industry," was how Mr. F. G. C. Fison, chairman of Fisons, Ltd., described his company's response to the Government's appeal in 1944 that the fertiliser industry should put forward plans for increased production.

When the company's projects were completed in about 12 months' time, annual productive capacity of sulphuric acid would be increased by 120,000 tons, of superphosphate by 90,000 tons, of granular complete fertilisers by 450,000 tons.

70,000 tons a year of triple superphosphate would also be produced, a fertiliser which had not hitherto been manufactured in this country. The cost of the complete programme would be £5.5 million.

Mr. Fison was speaking at the annual meeting of the company in Ipswich.

FUTURE OF I.G. FARBEN

Capacities and Use of Assets

THE unfailing interest concerning the future of the I.G. Farbenindustrie group, especially in the Federal German Republic, lends added importance to an investigation written by Dr. Hermann Gross, of the Institute for World Economy, Kiel University. This paper gives fairly full data about the turnover and number of workers of the various units of the group, in particular about the three major units which are to be established as a result of the liquidation of the I.G.

Fixed assets of the I.G. are reported to have amounted to a book value of RM.1.95 milliard on September 30, 1944; of this 57.9 per cent or RM.1.13 milliards are accounted for by units situated outside the Federal German Republic—more than half a milliard RM. in the Soviet Russian zone and in the Russian sector of Berlin.

Dr. Gross states that 33.6 per cent of the value of fixed assets will be accounted for by the proposed three new units: the Badische Anilin- und Sodafabrik, Ludwigshafen-Oppau, the Farbenfabrik Bayer in Leverkusen (which also has plants in Elberfeld, Uerdingen and Dormagen) and the Farbwerke Hoechst (with other works in the neighbourhood of Frankfurt). Individual shares of these three proposed units are:— 18.8 per cent.; 8.5 per cent; and 6.8 per cent respectively.

In the last financial year (July 1, 1948, to June 30, 1949) the proposed Leverkusen unit (Bayer) had the biggest turnover—DM.280 million, and the number of persons employed totalled 25,800. The turnover of Ludwigshafen amounted to DM.162 million and the number of employed to 21,900, while the figures for Hoechst were: DM.150 million, employing 12,800.

In 1938, the I.G. employed 218,000 persons and had a turnover of RM.2.2 milliard and the figures for 1943 are 333,000 employees and a turnover of RM.4.13 milliard. These figures indicate that the proposed three new units would be less powerful than the former I.G. but would still remain sufficiently influential to make unwise any relaxation of watchfulness on the part of the Allies.

More German Plant as Reparations

The Buna research and testing plant belonging to Chemische Werke Huels, G.m.b.H., Maal-Recklinghausen, has been indicated by the High Commission in Germany as being available as reparations.

POTENTIALITIES OF TITANIUM

Sir Ben Lockspeiser on British N-F Metal Research

SOME of the valuable results of investigations carried out by the British Non-Ferrous Metals Association were called to mind by Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, when he opened the association's laboratory extensions last week.

One of the main problems long associated with the use of metals was corrosion, said Sir Ben. A great deal of credit for freeing ships of the Royal Navy from trouble due to corrosion of condenser tubes could be attributed to the association. Its work had established the beneficial effects of iron and manganese in the cupro-nickel tube and had also demonstrated the merits of a new condenser tube material, namely, aluminium-brass.

Quality control in manufacture was of great importance, and the lead industry had invited the co-operation of the association in a study of commercial production plant with a view to defining the conditions under which control of the quality of the product could be more readily secured in practice.

Workshop Studies

Investigators of the association had spent nearly a year in the members' works studying production methods. To form a sure basis of progress it had been found that more basic knowledge was necessary.

This had meant installation of equipment to deal with work of a larger scale than was normally possible, and this could be seen in the basement of the new laboratory. The association could now use in the 500-ton hydraulic press a sub-press on which lead billets 6 in. long and 6 in. diameter could be extruded under controlled conditions and the precise effect of certain variables ascertained.

Much new ground was being covered by the association and one of the most important items was the study of the properties of titanium, hitherto a comparatively neglected metal. Its density is not much more than half that of steel and it has a very high melting point—over 1700°C.

Metals that are not too heavy and yet can maintain a high strength at high temperature were being increasingly required—for example for gas turbine blades and combustion chambers generally.

The association had shown, contrary to general belief, that the strength of this metal could reach a value of nearly 70 tons p.s.i. combined with good ductility, and this did not require a high degree of purity.

Sir Ben showed a specimen which contained a considerable proportion of carbon and iron, but yet had a tensile strength between 60 and 70 tons p.s.i. Alloys, he pointed out, might do even better than this.

Titanium was abundant and widely distributed in the form of its oxide. It was at present comparatively expensive to make, continued Sir Ben; but it should be remembered that when aluminium was first made it cost 17s. per lb. with the value of a shilling as it then was, whereas the price now was only 1s. per lb.

The present expense of the material need not be discouraging. "All work of this character is a bit of a gamble," concluded the speaker, "but so are all adventures. We have to have courage in our science as in other forms of activity; and, if courage is combined with good judgment, we often get startling results. We must always be prepared for the unexpected, even though it may be a source of embarrassment when it occurs, because it is the unexpected things which often lead to a revolution."

Finally, Sir Ben referred to the right kind of spirit necessary in the laboratory where people should be encouraged to be courageous, and even break a few rules now and again if the spirit moved them. Under its director Dr. G. L. Bailey, he felt confident that the association's laboratory was a healthy one and would continue in its good work for industry.

French Lead for U.K.

ACCORDING to reports from Paris, the Société Minière et Métallurgique de Penarroya has concluded an agreement with the Ministry of Supply for the delivery of 18,000 tons of lead. The first shipment of 6000 tons is stated to have been made already and the company expects to deliver 1000 tons per month during the current year. The French company has promoted a rapid expansion of the lead and zinc mining activities of one of its Moroccan subsidiaries, the Société des Mines de Zellidja, using Marshall Aid funds Repayment of the credit of $3.6 million is to be effected by lead and zinc shipments for the U.S. strategic stockpile.

GELATIN AND GLUE RESEARCH

Wide Scope and Objectives of the New Association

FEW industries offer a wider field for research or one relatively so undeveloped as glue and gelatin production. The need for collective research has long been recognised, so that ready support was found for the British Gelatine and Glue Research Association when it was established with the support of the Department of Scientific and Industrial Research on June 30, 1948.

The scope for research in the gelatin and glue industry extends from the raw materials used in production to the methods of manufacture and the uses of the finished products. From the nature of the industry the research programme may also be considered to include by-products.

Gelatin and bone glue are entirely separate products, made by different processes. Hide glue is produced both incidentally in the course of gelatin manufacture and also by processes closely similar to those for gelatin. Both sectors of the industry are closely linked and manufacture their products almost entirely from waste materials.

Gelatin and hide glue are produced mainly from waste material supplied by tanneries, the best for gelatin manufacture being limed trimmings and pieces that are unsuitable for the leather industry. Local supplies of unlimed scrap are supplemented by the importation of a certain amount of materials such as dried sinews from India and the Argentine, which can be produced only in hot, dry climates.

Ossein

Another material for gelatin manufacture is ossein, which is obtained by removing all the inorganic constituents of bones with acid. Ossein is sometimes imported from Belgium, where hydrochloric acid is cheap.

The materials for the production of high-grade gelatin are usually pre-treated for about 12 weeks in a lime suspension. To improve the distribution of lime among the skins, the contents of the pits are periodically agitated and the liquor run off and replaced by fresh water and lime. This pre-treatment lowers the temperature at which gelatin can be extracted from the hide, and so limits the degradation caused during extraction. The clearness of the finished gelatin depends on the elimination of unwanted proteins and hence on the efficiency of the lime soak.

The improved extraction results from a change in the collagen itself. During the soaking period, collagen loses a small quantity of ammonia and becomes increasingly soluble in hot water. Thus, gradually increased yields of gelatin of strong jelly strength are obtainable as the soak progresses.

Skins, on leaving the lime pit, are thoroughly washed to remove alkalinity and bring them into proper condition for conversion to either gelatin or glue, according to their character. The conversion is carried out in kettles, which may be either wooden tubs, or, for gelatin, stainless steel or aluminium vats, and, for glue, mild steel tanks.

Digestion Process

The skins are left in water held at a temperature of 60°-75°C. and the gelatin solution is then run off, the concentration being a few per cent. The kettle is refilled and the digestion process repeated until the skins have almost entirely disappeared, the temperature being gradually raised during successive extractions. With each succeeding digestion there is a progressive diminution of jelly strength and viscosity.

The dilute solution from the kettles is run through a series of filters to remove any coarse suspended matter, and is then concentrated by evaporation. The viscous liquid thus produced is bleached and the *p*H is adjusted to increase resistance to bacterial attack. The concentrated liquor is run off and allowed to set to a jelly, which is cut into thick cakes and passed through a tunnel drier to remove the remainder of the water. Alternatively, the cakes can be formed by running the solution on to a chilled stainless steel belt.

Since no two batches of glue or gelatin are alike, reproducibility can only be achieved by blending different batches. This can only be done satisfactorily in some finely divided form such as powder, so that glue for most technical purposes and gelatin for both technical and culinary purposes are usually ground. By the time the dried cakes have been ground, test figures are available, which enable a product of fixed characteristics to be produced by blending. After blending, the powder is again tested in the laboratory.

The quality of gelatin is assessed very largely by the jelly strength (the elastic property of the jelly) and/or the viscosity of the gelatin solution, depending on the

application for which a particular batch is intended. Another important factor is colour, which tends to deepen as the time and temperature of extraction are increased.

It is important, therefore, that the processes of pre-treatment and conversion should be scientifically studied in order to minimise degradation and produce the maximum amount of high-grade material. Since the normal liming process occupies about three months, any means of shortening or facilitating that process might be of profound economic importance.

Molecular Structure

To facilitate the conversion of the raw materials into products, the Research Association considers it will be necessary to find out a great deal more about the actual structure of the gelatin molecule, in order to determine both the influence of heat and time on the molecule and the influence of modifications in pre-treatment on the products. Because collagen, an important constituent of the raw material, is insoluble in all ordinary solvents, a direct approach to the problem would present considerable difficulties, so that it may be easier to deduce what changes are going on in the raw materials by the changes noted in the end-product.

Study is being given to the properties of the solutions and gels which gelatin makes and to relate this with what can be found out about the structure of the gelatin molecule and its interactions. Identification of the small quantities of materials other than gelatin which may be present in the finished product will be an integral part of this work. Some of these materials are already well known and present no problem, such as the salts obtained from water used in processing, calcium from the liming operation, etc. There may also be small quantities of organic substances present in the raw materials, however, which might in particular circumstances modify the properties of the products.

The most important properties which it is hoped to relate to structure are the elastic properties, the study of which necessarily includes the mechanism of the gel formation. Other subjects for investigation include the viscous behaviour of the solution, the problems of adhesion and swelling, the diffusion of water in the gelatin and also the diffusion of ions. The behaviour of gelatin at an interface—*i.e.*, between an oil and water surface—will also be examined, and this investigation will lead to study of the emulsions in which gelatin is used as an emulsifying agent. Attention will also be devoted to the various ways in which reactive groups of gelatin can combine.

Further scope for research is presented by the elimination of metallic contamination. Edible gelatin has to conform to a specification of 1.4 parts of arsenic per million, a limit which seems unduly low when compared with arsenic contents of 36-110 parts per million in lobster or 40-174 parts in prawns. The explanation is that the limit was drawn up in the first place to cover food products consumed in substantial quantities without dilution, whereas table gelatin is usually diluted to a considerable extent.

A process in which arsenic is separated from a gelatin solution by the use of finely divided alumina is the subject of a very recent patent by George Nelson, Dale & Co., Ltd.

Another aspect of the research programme involves the important question of bacteriological control throughout the process, which is essentially a matter of considering the various stages of manufacture and determining the points at which difficulties are liable to arise. The total count of bacteria may be wholly misleading, however, since many of the bacteria might be unimportant. Bacteria, present in the raw materials, when conditions are right for their growth, may modify the gelatin and also produce waste products.

Having an understanding of some of the problems, it may be possible to apply some of the knowledge gained to the uses of gelatin. This might result in the development of products capable of being used for new applications either as they stand or after suitable modifications.

Impurities

The lowest extractions in gelatin manufacture, or special extractions of certain types of material such as rabbit skins, become hide glue. The only differences between these products and gelatin are that the former are more degraded and normally contain more impurities, since they come mainly from fleshings which have not had long lime treatment, or from materials which may not have been limed.

The traditional way of making hide glue is to boil up the material with water until the solution is strong enough to set, a process which considerably degrades the material. Modern practice is to extract as much gelatin as possible and convert the remainder of the material into glue.

Bone glue is also a product of waste material, which in this instance consists mainly of "home bones" from butchers and slaughter houses, etc. A certain

amount of imported bones is also used, but these are much more costly than the local products.

As a rule, the bones, after breaking down and pre-treatment to remove meat residue, are steeped in sulphur dioxide water. The glue is then extracted in autoclaves by pressure steam and extraction with water. Early extractions are usually evaporated as such, but in subsequent ones the liquor from the previous digestion may be used once or several times. Preservatives are often added and the product is then evaporated until it will set on cooling. The subsequent processes of manufacture leading to the finished product have already been described.

Since bone glue is a cheaper product than gelatin and the plant used in its production is much less flexible, the introduction of substantial modifications in manufacturing methods would probably be uneconomic. It is therefore anticipated that research in the bone glue industry will be concentrated more on properties and applications and less on the manufacturing processes. Much of the general work detailed for gelatin will be equally applicable to bone glue.

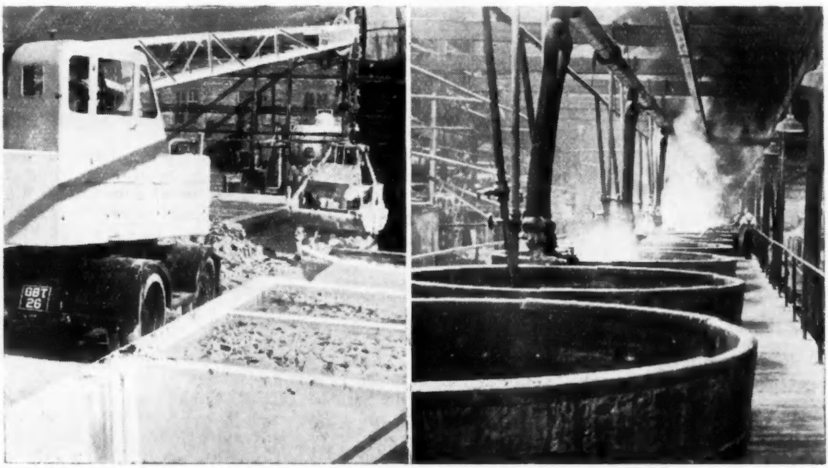
The by-products of this industry are extremely important, since they afford principally high value fertilisers and animal feed, and the fats are used mainly in soap-making. Virtually everything in the raw material which goes into the factory to produce gelatin or glue helps to form a product serving some useful purpose.

Probably the widest field for research is presented by the numerous applications for gelatin and glue, the association's approach to which will be governed largely by the information derived from fundamental studies.

Gelatin is used extensively in photographic emulsions, its desirable properties for this application including elasticity, power of setting, adhesion, ability to allow diffusion, etc. It is capable of being hardened and also stabilises the suspension of silver halide particles. The presence of certain trace compounds also sensitises the emulsions.

Such general properties as swelling, setting, etc., will be studied in connection with the general programme, and data of value to the photographic industry may well result.

The food industry uses gelatin largely for glazing, and as an edible emulsifying agent, apart from the use in table jellies. For these applications the most important properties, generally speaking, are the



[Courtesy, Richard Hodgson & Sons, Ltd.

Left: Mechanical handling of hide pieces in the limeyard. Right: Extraction of technical gelatin from fleshings

elastic properties and setting point, and to a lesser extent colour. All gelatin use for foodstuffs must, of course, conform to the requirements of the Edible Food Order in regard to freedom from arsenic and heavy metals, and a satisfactory bacterial condition is obviously important.

Both gelatin and glue are used in a wide variety of industries for sizing paper, textiles, wallpaper, carpets, tapestries, and many other articles. The most desirable properties for these applications appear to be adhesion to the substance being sized, strength of the gelatin or glue film, its surface properties, and the viscosity of the solution when applied.

The principal use of glue is as an adhesive for wood, but both glue and gelatin are also used as binders for solid powders, as in match heads and sand and emery papers. Here the problems to be studied include viscous behaviour, rate of setting, and the rate of deterioration on heating.

Research relating to adhesive applications involves the fundamental problem of improving the water-resistance of glue. At present glue is not used as an adhesive for plywood for outside use because of its hygroscopicity. It is obviously desirable that this limitation should be overcome.

The printing industry uses gelatin and glue in photolithography, collotype, etc., an application which depends on the light hardening reaction in the presence of bichromates. This reaction is little understood. Print rollers rely on their elastic properties and resistance to wear, and reduction of swelling at high temperatures would therefore be advantageous.

A high-grade gelatin is used in the manufacture of pharmaceutical capsules. There is, in fact, hardly an industry in which no applications can be found for either gelatin or glue.

The field for research is truly enormous and it is obvious that in its initial approach to the problems the association will have to be selective. Nevertheless, the work requires to be planned comprehensively as a single programme, in order that the various aspects of research can be co-ordinated and correlated. A broad programme of work for the next few years has therefore been mapped out, as well as an immediate programme which is already under way. The fields selected for immediate study include molecular weight and dimensions, viscosity and elasticity, degradation by heat, the formation of colour, and bacterial problems.

Foreign Studies of Colloid Effects

Changing Views of Ageing and Rancidity

COLLOIDS evolve and develop under the influence of factors about which relatively little is known and to which no profound study has been given, despite the great activity of colloid chemists and physicists during the past half century.

This is the view of W. Kopaczewski, a leading authority in colloid research, who gives examples (*Chim. et Ind.*, 1950, 63, 27-33, Jan.) to show that ageing may prove beneficial, as in the case of wines and spirits, of clays in Chinese porcelain manufacture and of photographic plates to improve their sensitivity; or adversely as in the loss of potency of mineral spring water away from its environment, or in the reduced elasticity of rubber. There is as yet no wholly satisfactory explanation of these changes.

The extensive literature of the subject reviewed by Kopaczewski covers many other examples of ageing in most fields of industry, including metal corrosion, soap hydrosols, gelatin, lime and cement, clays, paper, fats, etc.

Particularly interesting cases are those of oils and fats and rubber. In the first the causes of ageing or rancidity have not by any means been fully explained. It has been shown, indeed, that the change occurs only in the presence of light and moisture.

Micro-organisms do not appear to play a leading part here, since, according to Husa, rancidity of sweet almond oil may take place even in the presence of antiseptics such as benzoic and salicylic acids or hydroquinone. It has also been noted more readily in sheet tin containers than in those of other kinds. In any case it is accompanied, chemically, by saponification, and physically by emulsification of the saponification products. Hydrolysis or oxidation alone does not appear as an effective cause.

Uncertainty as to the real mechanism of rancidity explains the numerous purely empirical methods proposed for overcoming it.

Ageing of rubber is a well known phenomenon, due chiefly to oxidation, by which the rubber loses flexibility and becomes hard and brittle. If protected from air and light, vulcanised rubber does not age.

INSECTICIDES IN TREATED FOODSTUFFS

Isotopic Tracer Study of "Take-up"

TO determine minute traces of fumigants and other insecticides present in treated foodstuffs and in insects, work has been started on the use of radioactive materials. A special DSIR laboratory has been equipped and initial experimental work has been carried out with the fumigant methyl bromide labelled with radioactive bromine of half-life 34 hours (Br^{82}).

It was first necessary to work out all the details for its synthesis on the millimole scale under conditions suitable for radioactive material. Yields of about 90 per cent theoretical were eventually obtained, the product having a boiling point within 0.1°C. of the theoretical value, boiling point being taken as the criterion of purity. This method is now in use for the preparation of radioactive methyl bromide from active potassium bromide prepared in the atomic pile at Harwell, states the Report of the Director of Pest Infestation Research, Department of Scientific and Industrial Research, recently published (HMSO, 1s. net).

Preliminary experiments with labelled methyl bromide were made with the object of gaining experience with radioactive material and testing the envisaged applications. This work also necessitated the design of a reproducible experimental technique for the accurate assay of bromine radioactivity. The sensitivity of the methods appeared to be at least as great as that calculated.

Accurate Determination

Using the prepared labelled methyl bromide, weights less than 0.05 microgram could be determined to within a few per cent. This means, for example, that methyl bromide of the order of 0.01 parts per million could be estimated with similar accuracy. Methyl bromide concentrations in air of about 0.1 mg. per litre in 1-c.c. samples could be determined to within two or three per cent. Comparable accuracy by normal electrometric or chemical methods using 1 litre samples would be considered satisfactory.

The electrometric method for determining small methyl bromide residues in tobacco was tested, using labelled fumigant. Chemical and electrometric methods are normally handicapped by the presence of considerable quantities of natural bromide and chloride.

A method was successfully developed for the continuous measurement of the rates of sorption of labelled methyl bromide by various substances. The method will shortly be applied on a useful scale. Sorption data which have practical and fundamental applications will be accumulated far more rapidly and with greater accuracy by using labelled fumigant.

Labelled methyl bromide is being used in the microscopic location of fumigant taken up by insects exposed to the vapour. In this field progress has so far been made only in experimental technique, but the first results, states the DSIR report, are promising.

Distribution in Insects

The radioactivity of labelled methyl bromide fixed by insect tissue is likely to be in the form of water-soluble bromide, so that the methods of fixing dehydration, etc., normally preceding histological examination must be avoided as they would certainly affect the distribution of the insecticide in the insect tissue.

The method of Altmann (1890) developed by Gersh (1932) in the U.S.A. has been modified for the present studies. Insects killed by exposure to labelled methyl bromide are plunged into isopentane at −180°C. The frozen tissue is then transferred to a chamber at −30°C. and the water in the tissue (present as ice) distilled off at a pressure of 10^{-4} mm. mercury. The process of dehydration is followed on the Pirani gauge.

The tissue is next embedded under vacuum and sectioned. The sections are then treated with photographic emulsion, processed, stained and examined microscopically. The emulsion responds to the radiation from the fixed insecticide and the method is termed auto-radiography. It has been successfully applied by other workers to the location of radio-iodine in thyroid and radio-phosphorus in plants, bone, etc.

At some stage in radioactive tracer work it is necessary to measure quantitatively the radioactivity of samples. Electronic equipment designed for this purpose was therefore assembled. Much of this equipment was made available by the Atomic Energy Research Establishment.

The assembled apparatus was tested with standards of known radioactivity. Various characteristics such as "recovery times" had to be determined by means of a

cathode-ray oscillograph before proceeding with quantitative work. Certain aspects of the equipment were also studied in order that a limited amount of servicing could be done on the spot.

The possibility of using synthetic insecticides for the control of stored-food pests has been found by the DSIR pest infestation research laboratory to depend very largely on the amount of insecticide that may be taken up by exposed foodstuffs. To this end, work has continued on the measurement of DDT residues in foodstuffs stored in sacks impregnated with insecticide. The amount absorbed was in some cases surprisingly high, and can be shown to be largely dependent on the fat content and the fineness of division of the foodstuff.

Work on DDT smokes has included measurements of the toxicity to insects of the actual smoke and of the films of DDT formed by the deposition of the smoke on building surfaces. It was found that not only were the deposits about 20 times as heavy on the floor as on the walls and ceiling, but, surprisingly, the deposits at floor level contained 66 per cent, by weight, of DDT. Those on the walls and ceiling contained only 12 per cent.

FOREIGN STUDIES OF COLLOID EFFECTS

(*continued from page 294*)

Earlier views on this subject have, however, been considerably modified by the work of Stevens, Moureux et Dufraisse, Evans and the Research Association of British Rubber Manufacturers.

In regard to the important field of pharmaceuticals, including sera, the author in 1934 investigated the physico-chemical changes occurring through ageing while kept under antiseptic conditions. He extended his studies in 1938, arriving at the following tentative conclusions: viscosity of the serum increases, surface tension falls considerably, *p*H has periodic changes, and lacto-gelling is increasingly retarded.

On examining their chemical composition in 1947, especially that of the deposit formed, it was found that the latter consists of 64 per cent protein and 34 per cent calcium salts of fatty acid (lime soaps) having a melting point of 48-49° C.

Similar results have lately been reported by Polonowski (*Comptes Rendus*, 1948, *227*, 1420). In view of the presence of these lime soaps Bertrand (*ibid*, p. 1308) has proposed to decalcify these curative sera by adding sodium oxalate (See also the 2nd edition of the author's work, "The Colloidal State and Industry," 1949).

Investigation of the various chemical and physical factors revealed the following effects. To start with, mechanical stirring permits the separation of albumin or rubber from their dispersions; it inactivates ferments; and often a definite shock may cause labilisation, *e.g.*, as by explosion. This is the case with aqueous emulsions of petrol, benzene, etc.

Heating colloids also has a labilising effect, with resulting flocculation, coagulation, or liquefaction.

The effect of radiation is less definite, except that in the short wave range. It has been found when irradiating an aqueous dispersion of gelatin with ultraviolet rays there is a marked change in structure. With blood serum flocculation may occur. According to Rajewski, this has a periodicity corresponding to the time of exposure.

Improved methods of determining radiant energy, due to de Broglie and others, have facilitated observations in this field, as also have many improvements in microscopic technique in recent years. Radium emanations, electric discharge—*e.g.*, during thunderstorms—cosmic rays, magnetic storms, are other physical factors that may be mentioned.

The author refers to the interesting point which has often been emphasised, that the colloidal state represents a transition between the molecular state, governed by the laws of chemistry, and the particulate state mainly subject to the laws of physics; though there are varying intermediate stages.

Particle size and dispersion are naturally of great importance, as shown in the industrial properties of kaolin and photgraphic plates, and stability is largely dependent on these two factors. Other important considerations affecting stability are: the electric charge carried by the colloidal micelles, interfacial tension, and viscosity of the intramicellar liquid.

All this stresses the importance of the growing science of electrocapillary chemistry, which mainly originated in France, and holds the promise of fundamental advance in colloid technology.

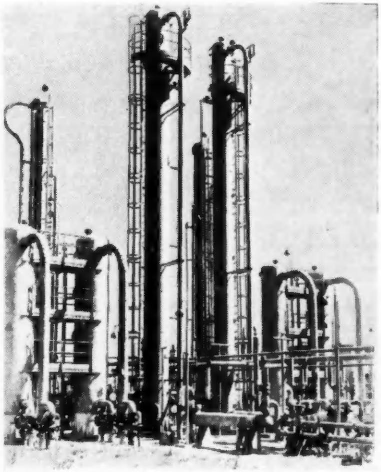
Portugal's Chemical Industry

The article on page 279 of our issue dated February 18, " Portugal's Chemical Industry," was mistakenly attributed to our French contemporary *Chimie et Industrie*. It should have been credited to the German journal *Chemische Industrie*.

HELIUM ENGINEERING

Vast Storage in the U.S.A.

From A CORRESPONDENT



TO conserve surplus helium, a vast storage reservoir is being used in Texas by the U.S. Bureau of Mines. This is made possible by the completion of a 32-mile pipeline between the Exell and Amarillo helium plants and of pipeline connections with the Cliffside natural gas field, where the gas is pumped into one of 11 producing wells. U.S. production of helium in one year totalled more than 63 million cu. ft.

Although the helium must be repurified when it is withdrawn, the gas from the cache is extremely rich in helium content, the processing time is reduced and there are immediate supplies available.

Almost all helium to be returned to the ground comes from the Exell plant, where U.S. Bureau of Mines—the only producer of helium in the U.S.A.—extracts it from

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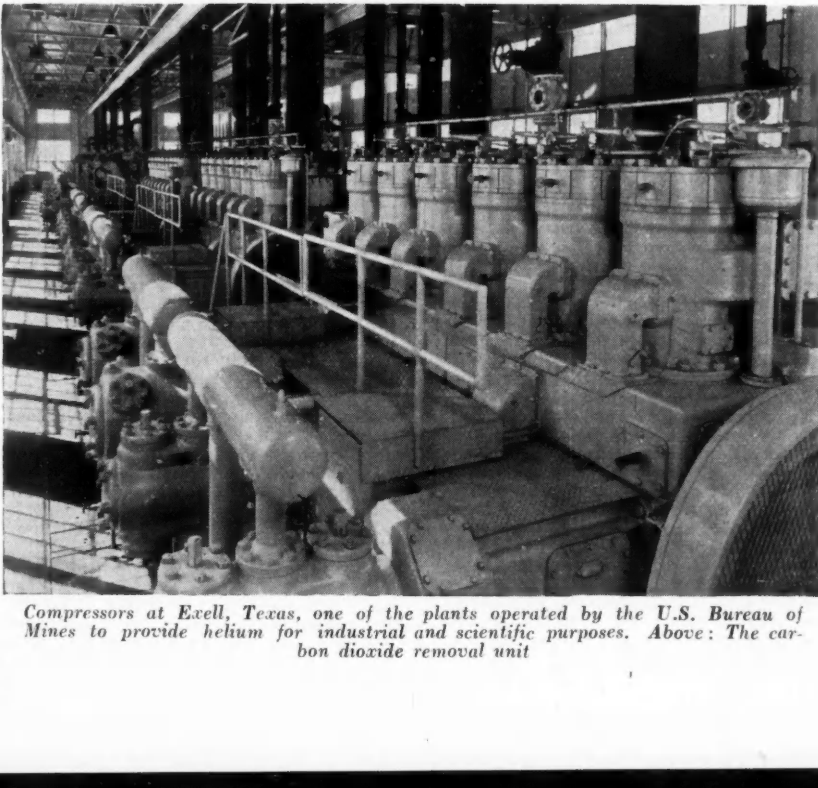

Compressors at Exell, Texas, one of the plants operated by the U.S. Bureau of Mines to provide helium for industrial and scientific purposes. Above: The carbon dioxide removal unit

Basis of New Fluorinated Materials

Use of Trifluoro Acetic Acid in Thermoplastics

From A SPECIAL CORRESPONDENT

TRIFLUORO acetic acid (CF_3COOH) is one of the important new materials contributing to the synthesis of a number of fluorinated compounds. It can be used in the production of vinyl trifluoro acetate (b.p. 39.5-40.5°C.) by the reaction of acetylene with the acid, using mercuric oxide or sulphate as a catalyst.

Polyvinyl trifluoro acetate is a potentially valuable thermoplastic which may one day be developed on an appreciable commercial scale. The vinyl polymers are described in U.S. patent 2,436,144 and British patent 589,197. Some of the esters made by reacting trifluoro acetic acid with alcohols in the presence of mineral acids may be of interest as solvents.

This is also the starting material for the manufacture of fluorinated azo dyes for cellulose derivatives, silk, wool and nylon. Here the trifluoro acetamide group is used in the preparation of the colours; the amide can be made by reacting ammonia with ethyl trifluoro acetate in anhydrous ether.

An important application of the acid is in the manufacture of fluorocarbons, *e.g.*, by the electrolysis of the sodium salt of trifluoro acetic acid, hexafluoroethane can be prepared. Fluorocarbons now embrace plasticisers, lubricants and polymers such as polytetrafluoroethylene.

Another interesting application of trifluoro acetic acid is as an acid condensing agent, *i.e.*, the condensing of acetic anhydride with anisole to produce *p*-methoxyaceto phenone (Newman, *Amer. Chem. Soc.*, 67, 345 (1945). It has also been suggested that trifluoro acetic acid might be useful as a nitrating medium.

A large number of the organic compounds made from trifluoro acetic acid have not yet been fully evaluated. Among the interesting chemicals which can be formed are trifluoro acetophenone by reacting trifluoro acetyl chloride with benzene in the presence of aluminium chloride, and α-trifluoro-*p*-phenylacetophenone by reacting trifluoro acetyl chloride with diphenyl in the presence of aluminium chloride.

Basic Characteristics

Trifluoro acetic acid is a highly corrosive, colourless acid possessing a strong, pungent smell. It has a boiling point of 71.1°C. at 734 mm. and freezing point −15.3°C. The acid is completely miscible with water, ether, petroleum ether, acetone, methanol, and a number of other common solvents, but insoluble in mineral oil and carbon disulphide. Trifluoro acetic acid forms a constant boiling mixture with water; the mixture contains 79.4 per cent trifluoro acetic acid and boils at 105.5°C.

The acid is very hydroscopic and glass bottles containing it need to be packed securely. Either glass stoppers or polystyrene caps containing PTFE liner are recommended. Ordinary closures made of cork, rubber, phenolic mouldings and polythene are all attacked by the acid.

The low surface tension, 14.2 dynes/cm. at 30°C. makes it difficult to seal bottles tightly as the acid shows a marked tendency to creep. Metal vessels cannot be used for handling or storing trifluoro acetic acid as practically all non-ferrous and ferrous metals are attacked.

HELIUM ENGINEERING

(*continued from previous page*)

natural gas flowing to industrial and commercial plants. Limited storage facilities have in the past made it necessary to allow large quantities of natural gas still containing helium to be marketed.

The pipeline—the second of its kind constructed by the Bureau—serves two main purposes. It carries the excess helium from the Exell plant to the Cliffside well and transports helium from Exell to the Amarillo plant for leading into tank cars. Moreover, the production capacity of the Amarillo plant is not limited to gas from the original Cliffside field, but is greatly increased by processing the high-purity helium from the underground storage.

To construct the Amarillo-Exell line, pressure welding was employed so that a virtually unbroken 2-in. cylinder was extended for 32 miles. Before being coated and wrapped to minimise corrosion, the line was filled with natural gas and carefully examined for leaks by water test.

To guard against damage and loss of helium in the event of a break a series of valves automatically close the pipeline on each side of the break, thus preventing loss of the helium in the lines.

THE MINOR CONSTITUENTS OF COAL

Wide Range of Organic Materials and Metals

by A. C. MONKHOUSE, B.Sc., Ph.D., F.R.I.C.*

NITROGEN is found in all coals and amounts to 1-2 per cent. It is derived mainly from the proteins or other nitrogen-containing compounds of the original plants, but a portion may come from animal proteins. No definite information is available of the form of these nitrogen compounds.

Solvent extraction is not very successful in removing nitrogen products. High vacuum distillation at a low temperature[1] gave a small quantity of nitrogen bases.

Several workers[2,3], by heating coals at varying temperatures and comparing the behaviour of the nitrogen with that of known nitrogen compounds, have postulated the presence of an amino group, or a substituted amino group in coal, but whether they exist as such in the original coal or are, as is more probable, a secondary product produced by heating the coal, is not known.

Treatment with sulphuric acid[4] has shown that 5 per cent of the original nitrogen of the coal can be extracted; mono-amino acids and amides are present in the extracts. By oxidation by the Kjeldahl method[5] nicotinic acid has been said to be isolated, giving evidence of a heterocyclic-ring system in coal.

Oxidation experiments at the Fuel Research Station[6] using alkaline hypobromite, showed the presence of a small quantity of 1:3:5 tribromo-aniline, indicating association of a part of the nitrogen with a carbocyclic ring. There still remains considerable work to be done before a definite answer can be given as to the constitution of the nitrogen compounds in coal.

Liberation of Ammonia

During coal carbonisation nitrogen is first liberated as ammonia between 315°C. and 400°C.; the evolution continues with rising temperature, reaching a maximum at about 800°C., when the liberation of ammonia ceases.

The percentage of the nitrogen evolved as ammonia is small, amounting to 11-17 per cent; the greatest portion is left in the coke and amounts to 50-80 per cent. The remainder is found in the tar bases, or in the gas as hydrogen cyanide and nitrogen. Under certain conditions during carbonisation hydrogen can increase the proportion of nitrogen evolved as ammonia,[7,3] but its action is limited.

The nitrogen left in the coke is in a very stable form and can be liberated only as ammonia by gasification of the coke. It has been shown[8,9] that the carbon-nitrogen ratio remains constant during gasification, indicating that the nitrogen is combined with the carbon and cannot be liberated. Advantage is taken of this in the Mond system of gasification, in which air, saturated with steam, is passed through the fuel bed. Yields of ammonia are obtained equivalent to 70 per cent of the original nitrogen of the coal.

Ammonium Sulphate

At all coke ovens and many gas works the ammonia is recovered as ammonium sulphate, the ammonia being absorbed in sulphuric acid. The amount recovered by carbonisation in Great Britain amounts to over 300,000 tons per annum.

About 3 per cent of the nitrogen of coal is found in the tar from carbonisation, mainly as bases such as pyridine, and 1-1.5 per cent of the nitrogen cyanide in the gas, or as ammonium cyanide in the ammonia liquor.

The next most important element is sulphur, which occurs not only in the organic material, but also in the inorganic material, or mineral matter of coal.

The inorganic sulphur of coal exists mainly as pyrites and marcasite, with some sulphate, usually calcium sulphate. The organic sulphur may be derived partly from the sulphur compounds of the original vegetation from which the coal is formed, and partly from the action of sulphur bacteria on iron sulphate and organic matter.

Attempts have been made to extract from coal compounds containing sulphur. Traces of mercaptans and di-sulphides have been found, but the main sulphur compounds cannot be extracted. There is some indication that the organic sulphur compounds, and the nitrogen compounds are part of the fundamental composition of coal.[10]

Iron pyrites is the main inorganic sulphur compound. It can occur as layers in the coal bed, as modules and lumps, or

* Abstract of a paper presented before the Royal Institute of Chemistry and the Woolwich Polytechnic Scientific Society at Woolwich, November 28.

as minute particles dispersed throughout the mass of coal. The pyrites may have been formed by the reduction of iron sulphate by organic matter. Another possible mode of formation is by the interaction of hydrogen sulphide, evolved during decay of the vegetable matter, with iron salts.

The total sulphur of British coal ranges from 0.5 to 4.0 per cent. If the sulphur is in the pyritic form it may be possible to reduce the sulphur content of coal by mechanical cleaning, either in dry cleaners or wet washers.

Pyrites

Before 1939 there was a limited recovery of lump coal pyrites, amounting to 4000 to 5000 tons per annum. This was used for the production of sulphuric acid, but it provided only about 1 per cent of the total production—a negligible amount. During the wartime demand for sulphur-containing materials for the manufacture of sulphuric acid, in addition to increasing the amount of lump pyrites recovered, plant was installed at eight collieries[11] for the recovery of coal-pyrites fines. The production of coal pyrites was increased to 10,000 tons of lump per annum, and 25,000 tons of fines, equivalent to 5 per cent of the sulphuric acid industry's total requirements. One advantage of coal pyrites is that it is relatively free from arsenic.

When coal is burnt, the major portion of the sulphur is converted to oxides of sulphur, mainly sulphur dioxide. It is estimated that the total pollution, calculated as sulphur dioxide, amounts to about five million tons a year, of which one-fifth is from domestic appliances.

The removal of oxides of sulphur from chimney gases involves complicated washing equipment and is very costly, and no marketable product is recovered. Plants were installed at two power stations in London—Battersea and Fulham—and for a time at Tir John in South Wales. The cost before the war was two to three shillings per ton of coal burnt, but today's cost has been estimated at nearer ten shillings a ton. A cheaper process is required, one that would be applicable, not only to large boiler installations, but also to smaller ones, and one that would produce a marketable product, preferably sulphur.

Besides the damage caused by the oxides of sulphur emitted when coal is burnt, sulphur in the coal is also responsible for the formation of deposits on the tubes of generators and superheaters.

The bonded deposits consist of a matrix of sulphates or acid sulphates of sodium and potassium, in which are embedded particles of ash carried forward from the boiler fire. The inner layer of such deposits may contain 50 to 70 per cent of acid sulphates, while the outer layer deposited under hotter conditions contains 20 to 40 per cent of sulphates. Deposits on economiser tubes may contain up to 50 per cent of sulphates.

In the cooler parts of the boiler, such as the air pre-heater, acid deposits may occur which contain 50 per cent sulphur trioxide as sulphates and sulphuric acid. Conditions may be so bad that tubes or plates last only a few months before a replacement is required.

On carbonisation of coal, the sulphur is distributed between the products—coke, tar, ammonia liquor and gas. A typical distribution is:—

In coke	60	per cent
,, tar	1	,,
,, ammonia liquor as sulphide	10	,,
,, gas as H_2S	27	,,
,, gas as CS_2	2	,,

The removal of hydrogen sulphide from town's gas (a statutory requirement) is by passing the gas through boxes containing iron oxide by which the hydrogen sulphide is absorbed, forming iron sulphide. This, by oxidation or "revivification," is converted to sulphur and iron oxide which can be used again until the sulphur content is increased to about 50 per cent. It is then in a form suitable for the manufacture of sulphuric acid. Some 200,000 tons of spent oxide are burnt annually to yield some 250,000 tons of sulphuric acid, in terms of 100 per cent acid.

Other sulphur compounds in carbonisation gases[12] are carbon bisulphide, carbon oxysulphide, and thiophenes, of which carbon bisulphide and carbon oxysulphide are secondary products.

Phosphorus

There are a number of elements in coal whose proportion is very variable, and yet they may have a profound influence on the use to which the coal is put. One instance is phosphorus, of which the amount present in coal is from 0.001 to 0.1 per cent. The source of the phosphorus[13] is thought to be largely the associated minerals in the form of phosphates, often in conjunction with fluorine, e.g., calcium fluorapatite $3\,Ca_3(PO_4)_2.CaF_2$.

When coal is burnt in boilers, phosphorus compounds can be volatilised, and selective condensation in the boiler system can yield deposits containing 20 per cent of phosphorus from coals containing only 0.05 per cent of phosphorus.

Work at the Fuel Research Station has shown that reducing conditions and tem-

peratures higher than 1600° C. are necessary for the volatilisation of "combined" phosphorus, so that where coals rich in phosphorus are burned in certain types of stoking plant in boilers, these phosphate deposits may be found, particularly on generator superheater and economiser tubes.

Where coals rich in phosphorus are burnt in the pulverised form, only loose dusts are formed. The combustion in these circumstances approaches more nearly fully oxidising conditions. A phosphatic deposit, although not as common as a sulphatic one, is much more difficult to remove. The loss of time caused in cleaning boilers at electricity generating stations may amount for one boiler to several months each year.

The phosphorus, when coal is carbonised, is retained in the coke, and if the coke is used for metallurgical purposes, the phosphorus finds itself subsequently in the iron and steel, with detrimental effects. The phosphorus content of coke for certain metallurgical purposes is limited to under 0.02 per cent.

Chlorine is present in British coals from 0.01 to 1 per cent, the usual form being alkali chlorides, mainly sodium chloride.

The chlorine in coal cannot wholly be extracted by water. Cobb[14] showed that 100 gm. of coal, from which 0.38 gm. of chloride could be extracted as chloride in four hours by hot water, yielded a further 0.41 gm. on extraction with 10 per cent nitric acid.

In high-pressure boilers where the temperature of combustion is high, the alkali chlorides are volatilised and react with sulphur dioxide and sulphur trioxide to form bonded deposits on the boiler tubes.

In certain cases there is evidence of corrosion by hydrochloric acid, particularly when burning cokes rich in chlorine. This was noticeable in the coolers and filtering medium of small mobile producers, used during the war as substitutes on petrol-driven engines.

Arsenic Ash

Chlorine in coal can influence the volatility of the other elements present. One example is arsenic. A coal containing 60 parts of arsenic as As_2O_3 per million, 0.02 per cent of chlorine, and an unusually high proportion of carbonate when burnt, retained practically all the arsenic in the ash. When chloride was added to increase the chlorine content to 1 per cent the arsenic in the ash was reduced by over a half.

Another element whose effect has only recently been observed is fluorine. Lessing[15] observed in 1934 the breakdown of porcelain ring packing in a concentrated ammonia liquor scrubber at the Bristol gas works. This was attributed to fluorine compounds in the liquor being distilled.

Crossley[16], about the same time, showed that the etching of glassware in an annealing kiln was due to fluorine compounds from the combustion of the coal used. In both cases the coals were found to contain 85 to 140 parts per million of fluorine.

A survey of British coals showed that the fluorine content varied from five to 200 parts per million, fluorine being in the form of fluorapatite, so that the phosphorus content of coal gives a measure of the fluorine content.

High Fluorine Coals

Coals used for the drying of malt by direct contact with the gases are chosen with low arsenic content to avoid contamination of the malt. Similarly, the danger of contamination with fluorine is possible with high fluorine coals. Crossley examined six light ales, six brown ales, and 12 stouts, and found the average fluorine content 0.6 parts per million, of which 0.5 parts are contributed by the coal, and 0.1 parts by water. These analyses were from an area using low fluorine coals.

More than 30 elements have been found to be associated with the organic matter of coal.

Among the rare elements which have aroused interest in recent years is germanium. The detection of this in any quantity in coal ash was first reported by the late Dr. Goldschmidt.[17] He was examining spectrographically a number of German coals for trace elements, and as a comparison obtained from his local museum collection at Göttingen a 70-year-old sample of English coal labelled "Hartley, near Newcastle." The ash from this sample contained the phenomenally high figure of 1.1 per cent of germanium. It proved to be the richest specimen in germanium which has ever been examined.

One other picked sample from the Yard seam of the Hartley Main Collieries showed 1 per cent of germanium in the ash, but an examination of over 100 samples from the same and adjacent seams showed no figures higher than 0.5 per cent in the coal ash.

A number of tests on boiler deposits show the presence of germanium, and figures of 0.2 to 0.9 per cent of germanium have been reported. Consideration has been given to the possible recovery of germanium from selected dusts.

Germanium is volatilised from coal

during combustion, particularly in a reducing atmosphere, and its volatility is increased if chlorides are present. It is this volatility which is responsible for finding the germanium in the flue dust, rather than in the residual ash of the coal.

In an address at a recent meeting of the General Electric Company, the chairman, Sir Harry Railing, referred to the search made in **1945** for supplies of germanium for use in modern crystal diodes and triodes. A source was found in the flue dusts from Northumberland and Durham coals, and processes for the extraction of the germanium in a high state of purity have been developed.

Gallium

Another element which behaves in a similar manner to germanium is gallium. Again, this is found in larger quantities in the Northumberland and Durham coal fields. Flue dusts have been found derived from coal in these fields with from 0.04 to 0.55 per cent of gallium. One exceptional sample contained 1.58 per cent.

The association of the principal elements with the coal substances and their proportions in British coals are as follows:—

	Per cent in coal	Main source
Nitrogen	1–2	Coal substance
Sulphur	0.5–4.0	Coal substance and mineral matter
Phosphorus	0.001–0.1	Mineral matter*
Chlorine	0.01–1.0	Dispersed throughout coal substance
Fluorine	0.005–0.05	Mineral matter*
Arsenic	0.0001–0.006	Mineral matter*
Boron	0.0005–0.01	Mineral matter and coal substance
Germanium	0.0002–0.008	Coal substance
Gallium	0.0003–0.001	Coal substance
Vanadium	0.001–0.003	Coal substance
Lead	0.001–0.003	Mineral matter*
Copper	0.0005–0.005	Mineral matter*
Zinc	0.0005–0.7	Mineral matter*

* The Advantitious mineral matter.

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LEAD TETRA-ACETATE

A New Industrial Oxidising Agent

LEAD tetra-acetate, Pb $(C_2H_3O_2)_4$, is a comparatively new industrial chemical which is becoming of increasing importance, more especially in the U.S.A., as a highly selective oxidising agent in the synthesis of various organic compounds. It is notably important for splitting 1, 2-glycols into two molecules of aldehyde, the reaction being usually carried out in a solvent, such as glacial acetic acid, benzene dichlorethane and nitrobenzene, the velocity being lower in glacial acetic acid than in other solvents. To increase the velocity, water or methyl alcohol can be added.

In a similar way, alpha-hydroxy acids can also be oxidised and split by lead-tetra-acetate. Amino compounds like alpha-amino acids, 1, 2-amino alcohols and 1, 2-diamines, can be split by the lead salt to form an imine which may be further dehydrogenated to the nitrile. In addition, lead tetra-acetate is of great value in the methylation of aromatics and in acetoxylation. The latter can be used for the conversion of various allenes to cyclopropanone derivatives.

Commercial lead tetra-acetate usually contains 85-95 per cent active ingredient as tested by the idiometric titration of Dimroth and Schweitzer, *Ber*, *56*, 1375 (1923). In appearance this crystalline lead salt is colourless to faintly pink in colour and the crystals are always wet with glacial acetic acid.

Corrosion Problems

Like other lead salts, the tetra-acetate is poisonous. Moreover, as it is a strong oxidising agent and is wet with acid, handling and storage present serious corrosion problems. Materials recommended as safe for contact with lead tetra-acetate are stainless steels, glass, porcelain and certain plastics.

This lead compound is unstable and has a very limited life even when stored under the best conditions, *i.e.*, in a cool place with absence of light and moisture. When decomposition does take place it is possible to effect rejuvenation and some lightening of colour by stirring the lead tetra-acetate with half its weight of a mixture of eight parts glacial acetic acid plus one part acetic anhydride and then filtering off the solid tetra-acetate.

S. AFRICA'S NEW PRODUCTION PROGRAMME

Fuller Supplies of Native Materials and Products

From Our CAPE TOWN CORRESPONDENT

CONSIDERABLE impetus to South Africa's chrome industry is expected to result from research on chrome now being carried out by the Council for Industrial and Scientific Research. Officials say that the findings will be released to local industry as soon as possible, but the work is at present in its initial stages. It has been estimated by geologists that the Union has enough chrome to supply the world for the next 200 years. The Transvaal has rich deposits and some of the ore there is reported to be of a higher grade than that found anywhere else in the world. About 80 per cent of South Africa's chrome exports now go to the U.S.A., but development of the Union's own chrome ore industry will mean that the export figure must drop.

* * *

Ocean Products, Ltd., has decided to close its vitamin-oil factory at Gansbaai owing to the continued decline in the world price of this product, attributed partly to Japanese competition. One of this company's other interests, West Coast Fishing Industries, Ltd., is producing fishmeal and oil at the Walvis Bay factory, the demand for which is considerable in the Union and overseas and the prices obtained in the export markets higher than the controlled prices in the Union. As soon as the local demand has been met it is expected that export permits for fishmeal will be issued. The Fisheries Development Corporation, in its fifth annual report, referred to the setback suffered in the vitamin-oil industry in 1949. Now the picture is brighter, and a marked revival is expected, which should help to restore former price levels.

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C. F. and H. Rolfes Bros. (Pty.), Ltd., Elandsfontein Rail, Germiston, Transvaal, is now producing zinc yellows in two types. Both items are stated to have a low percentage of soluble non-chromate salts and to be excellent in combating rust. They are being made in accordance with U.S. Federal specification TT-Z-415 and U.S. Maritime Commission specification 52-MC-29, dated September 21, 1943. This firm expects in the near future to begin production of zinc greens.

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Laboratory glassware for individual requirements is now being made in Durban by a firm of wholesale manufacturing chemists, which recently established a special branch and engaged skilled glass blowers.

* * *

Import control has made it almost impossible for the University of Cape Town to obtain the chemical equipment needed for studies in the current year. No response has been received to applications for import permits for items such as chemicals, glassware and smaller apparatus, totalling £5830. Other universities in the Union appear to be labouring under similar difficulties.

* * *

G. and W. Base and Industrial Minerals, Johannesburg, now has its own mica mine in the Northern Transvaal, and is obtaining from it ruby sheet mica, which is sold under international mica grading.

* * *

A paint factory for the manufacture of high-quality nitro-cellulose alkydised motor-vehicle lacquers, also synthetic enamels suitable for spraying and brushing, was recently put into operation by a new firm in Cape Town. This concern is associated with several prominent Netherlands firms in the same field. Primer surfaces, glazing putty, thinners and other lines used in conjunction with its motor-body lacquers are also being produced. In addition, the firm manufactures a clear gloss alkydised furniture lacquer and a multi-purpose water paint.

* * *

Regi (Pty.), Ltd., Port Elizabeth, has placed on the local market a new plastic material which is stated to be composed to the extent of 90 per cent of local raw materials. It is claimed that articles can be made in comparatively inexpensive moulds and in any colour, with different surface tensions, both rigid and flexible.

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After nearly a year's negotiation with the Union Government, little progress has been made towards the establishment of an oil refinery at Durban. The managing director of Union Petroleum Refinery (Pty.), Ltd., is returning to Britain to consult his principals.

OVERSEAS

New Lead Deposits in Brazil

Deposits of lead-ore, reported to be the second largest in Brazil, have been discovered recently in Matozinhos Province, Minas Geraes.

Chile's Twenty-Nine Oil Wells

The first part of a Government plan for the production of petroleum in Chile has been completed. At a cost of 550 million pesos, 29 wells have been sunk at Cerro Manantiales, and eight in other parts of Magallanes Territory.

New Dutch Nitric Acid Principles

A new unit for the manufacture of nitric acid—the third—came into operation recently in the Dutch State coalmines in Limbourg. Almost the entire plant and equipment were made in Holland. Manufacture takes place according to a novel method, developed in the Central Research Institute in Lutterade.

New Chilean Zinc Plant

The Chilean Development Corporation has announced that work will commence shortly on the construction of a zinc refining plant near the existing steel works at Huachipato. Supplies of zinc concentrates will be obtained from mines at San Felipe. The industry is expected eventually to provide employment for about 500 workers.

Demand for German Barytes

Reports from Germany state that foreign demand for German-mined barytes has increased considerably in recent months. The enterprise which exploits the largest occurrences of apatite in Bad Lauterberg in the Harz Mountains is reported to be exporting about 60 per cent of its monthly output of some 200 metric tons, having found new markets in Latin America, especially in Uruguay.

Mining in Belgian Congo

The mining installation for the development of what is believed to be the most important uranium seam in the world is being constructed at Shinkolobine, in the Belgian Congo. Production is expected to be commenced towards the end of this year. An electrolytic plant for the production of zinc is also being constructed in the Belgian Congo by the Union Minière du Haut-Katanga near its existing zinc mine. This is expected to be completed some time in 1951 and to have a capacity of 100,000 tons of zinc annually. Power is to be supplied by hydraulic plant.

Swiss Paint Research

The Association des Chimistes de Vernis has created a study group on paint drying and the production of varnish by infrared rays. Research has started.

Coffee for Plastics

An American company is reported to have asked the Brazilian Government for excess coffee for use in plastics production by a process developed by the Polin Laboratories, New York.

Ruhr Lead and Zinc Deposits

Following recent investigations, it is reported that the Ruhr area contains the largest lead and zinc deposits in Europe. Occurrences of ore have already been ascertained in about 100 coal mines. Exploitation, however, is at present taking place in two mines only, because geological conditions do not permit a simultaneous mining of coal and ore.

Chrome Recovery

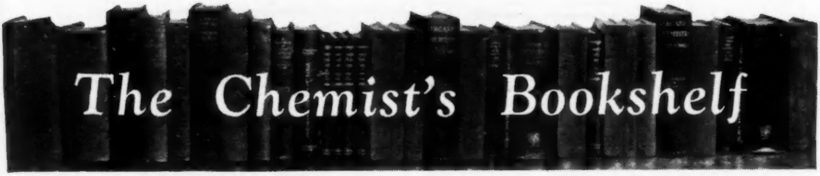
The possibility of reclaiming chromium waste from tanneries in New South Wales, Australia, is receiving attention from the State Government which estimates that in Sydney, the State capital, about 12,000 gallons of effluent a week are wasted. Practically all the discarded chrome could be recovered by simple methods, principally precipitation with lime, filtration and heating.

Fall in Swiss Shipments

Official Swiss export statistics for January 1950, show that the value of shipments by the chemical and pharmaceutical industries fell to Fr. 35.6 million from 54 million in December, 1949. Especially marked was the fall in exports of aniline dyes and indigo from Fr. 25.3 to 13.3 million in January, 1950. Exports of pharmaceuticals fell from Fr. 19.3 to 15.8 million and that of industrial chemicals to Fr. 5 million (Fr. 6.8 million).

Chilean Nitrate

An extraction process for the production of soda nitrate which has been perfected by an American engineer, Sherman Lesesne, will, it is expected, enable Chilean nitrate to compete with the synthetic product. A factory of the Antofagasta Nitrate Co. is operating the process at Tarapaca. It is called the butterfly process on account of the pipes being assembled on a tank lorry in approximately the form of wings. The product is not a pure sodium nitrate but a concentrated saline mixture which has to be refined before use as a fertiliser.



The Chemist's Bookshelf

THE COMING AGE OF WOOD. Egon Glesinger. Secker and Warburg, Ltd. 1950. Pp. xv, 279. 13 col. ill. 12s. 6d.

This is a book aimed at the general reader and consequently well charged with overtones and undertones. It is sometimes technically optimistic, forgetting the detailed failures and problems of to-day on the assumption that all will be put right tomorrow. But it is fundamentally sound, immensely readable, and stimulating.

Egon Glesinger, a Czech, has been associated with wood economics and wood politics since 1933, first with the European organisation, CIB, and then from 1946 with FAO's forestry department. This, however, is a personal statement of faith not an official document. Before the war Nazi Germany's technicians saw that wood had a widening future; during it, Sweden built up wood-based industries and so made her isolation more tolerable. Almost simultaneously a tough battle was fought between the alcohol industry and the potential wood-sugar alcohol industry in the U.S.A., a battle in which eventually a certain Senator Truman intervened. Glesinger tells the stories of these ventures as vividly as a New York columnist.

The second half of his book is more technical, but it does not entirely shed the bias of enthusiasm which characterises the first more general half. There are a number of technical and economic difficulties in using wood or such wood wastes as saw-dust as chemical starting-points, to which Glesinger attaches too little weight. However, he shows that all present economic costings of wood and wood products are ludicrously unreal because the various wood-consuming industries have failed to integrate themselves; the wastage of the timber industry would produce all the cellulose pulp the world requires.

Added to this wastage there is the vast fruitless production of lignin in pulp manufacture. But Glesinger is so confident that a new chemical industry will eventually be based upon lignin liquors, comparable to the gas industry's development of tar or to the new petroleum-based chemicals industry, that he fails to make the most of this vital point. The development of lignin is the key and he might justifiably have demanded more scientific attention to lignin, more research and more pilot-work. The certainty of establishing a lignin-based chemical industry would justify all ends to conservation.

Another point insufficiently discussed is the possibility that cellulose supplies can be economically based upon annual vegetable-type crops. Regarding this natural rival, Glesinger could have pointed out that trees thrive upon poorer soils than most agricultural crops, and that trees on high ground are essential for any sound water and soil conservation policy.

Despite these criticisms, this is a stimulating book for laymen and scientists. Coal and mineral reserves can be exhausted. Wood is the one carbon-hydrogen raw material which can be used prodigiously and replenished by re-planting. Egon Glesinger's age of wood is no empty vision.

ACID HANDLING. Imperial Smelting Corporation, Ltd., Avonmouth, Bristol. Pp. 68. 10s. 6d.

Modern methods of handling and transporting sulphuric and hydrofluoric acids comprise the main text of the book, which deals concisely with each phase of the subject. Materials of construction for containing the acids (cast iron and mild steel, special alloys and various non-ferrous metals) are discussed, and their composition, resistance to corrosion and suitability for specific purposes explained. In a chapter on pumps, the characteristics of several important types are set out, the operating efficiency of centrifugal pumps detailed by means of formulæ and diagrams, and considerations suggested in selecting a pump of suitable capacity. Another chapter gives instructions, in chronological sequence, for the safe transportation of sulphuric acid and requirements in the preparation of carboys and drums. Elaborate precautions against accident prevention are described and the protective clothing for workers, as well as other safeguards, are illustrated. Finally, anhydrous hydrofluoric acid is shown to engender no unusual danger when adequate precautions are taken.

· PERSONAL ·

PRINCESS ELIZABETH, DUCHESS OF EDINBURGH, was last week admitted a member of the Royal Institution of Great Britain and afterwards attended a lecture delivered by PROF. E. N. DA C. ANDRADE on "The Nature of Light."

MR. JOHN HITCHCOCK, who since 1946 has been personal assistant to the managing director, Mr. I. A. Bailey, has now been appointed to the newly created post of assistant managing director of Henry Wiggin & Co., Ltd., of Birmingham, manufacturers of nickel and high nickel alloys. Mr. Hitchcock was formerly a member of the Mond Nickel Company's development and research department staff.

SENOR JOSI MARIA ALBAREDA HERRERA, secretary-general of the Spanish Higher Council for Scientific Research, is at present on a three-week tour of Britain. Last week the Spanish soil scientist paid a return visit to the agriculture and physics departments of Leeds University which he last inspected in 1934 when he was working under Sir John Russell at Rothamsted Experimental Station.

MR. HUGH GLASS, of the process control division in the motor cover department at Fort Dunlop, has taken up his appointment as technical manager in Dunlop's Japanese factory at Kobe. MR. J. S. BIRCH has accompanied him as assistant production manager.

Birlec, Ltd., the Birmingham manufacturer of industrial furnaces, has appointed MR. G. P. TINKER as managing director, in succession to the late Mr. A. G. Lobley. Mr. Tinker, a director since 1946, has been a member of the executive staff of the company since its formation in 1927.

The Institution of Chemical Engineers has awarded the William McNab medal, for the best set of answers in the associate membership examination for 1949, to MR. MICHAEL SHAW, of Liverpool. The official presentation is to take place at the institution's 28th annual corporate meeting on April 14 at the May Fair Hotel, London. Mr. Shaw is with the research department of ICI general chemicals division, Widnes.

MR. P. T. HOULDCROFT, of the British Welding Research Association, left on February 15 for the U.S.A., where he will study for a period of from 3-6 months at Rensselaer Polytechnic Institute, Troy, New York, and for a further period, making a total of one year, in various industrial concerns. He will be concerned with the welding of light alloys, in particular fusion welding. Mr. Houldcroft is one of 50 research workers and technicians who have been chosen for similar scholarships provided by the ECA.

The British Council arranged for DR. W. A. ROACH, head of the biochemistry department of the East Malling Agricultural Research Station, Kent, to lecture at an agriculural congress held at the Royal Veterinary and Agricultural College in Copenhagen from February 22 to 25. He was to speak on "Deficiency Diseases in Plants" to horticultural and agricultural advisors from Scandinavian countries.

Obituary

THE death is announced at the age of 89, of PROFESSOR WILLIAM PALMER WYNNE, who was until 1931 Emeritus Professor of Chemistry at Sheffield University. Among his many appointments, he was elected, in 1913, president of the Chemistry Section B of the British Association. He served for two years each as hon. secretary and vice-president of the Chemical Society, of which he was president from 1923 to 1925 inclusive. He contributed many papers to learned journals.

The death has occurred in Glasgow of MR. ROBERT TATLOCK THOMSON, F.C.S., F.R.S.E., F.R.I.C., a Scottish analytical chemist of distinction, who, at 94, had clear recollections of his early association with Sir William Ramsay during early years of service with the family business. He founded R. R. Tatlock & Thomson, Glasgow and Clydebank.

The death has occurred, at the age of 85, of MR. FREDERICK WILLIAM CLARK, who was for ten years, from 1915, chairman of the Salt Manufacturers' Association. He was successively sales manager and managing director of the Salt Union, Ltd., which post he held until 1937, when the firm became associated with I.C.I., Ltd.

The death has occurred at Nunthorpe, Yorks., of MR. STANLEY SADLER, chairman of Sadler & Co., Ltd., chemical manufacturers, Middlesbrough. He was 73. Mr. Sadler had been a member of Middlesbrough Corporation, the Tees Conservancy Commission, Tees Valley Water Board, and the Tees Port Health Authority.

HOME

Laporte Chemicals' Extensions

Extensions to the central laboratories of Laporte Chemicals, Ltd., Luton, which have now been started, will include an experimental plant laboratory and add an area of 18,000 sq. ft. to the laboratories.

Aluminium Drawbridge

Aberdeen Harbour is to have an aluminium opening bridge of the bascule type built at Victoria Dock. The work, expected to cost £88,000, is being carried out by Head Wrightson Aldean, Ltd., a subsidiary of Head Wrightson & Co., Ltd., Thornaby-on-Tees, which constructed a similar bridge, the first of its kind, at Sunderland in 1948.

Mineral Gas Explosion

An explosion at the works of Sandoz Products, Ltd., Canal Road, Bradford, on February 13 was attributed to the collection of mineral gas at the mouth of a 700 ft. water borehole. The gas was believed to have been ignited by a spark from the electric motor of a pump which draws water from a 360 ft. pipe in the borehole.

Talks about Export

The Institute of Export announces an important new series of twenty Lunch Time Lectures on various aspects of export trade, to be held weekly at Conway Hall, Red Lion Square, London, W.C.2, between March 7 and August 1, 1950. Authorities will deal with such subjects as selling overseas, shipping, financing export and exchange and trade control.

Finance for North-East Expansion

Tees-side, the traditional iron and steel producing area, is to benefit by the investment of more than £100 million in its various industries, states the Chamber of Commerce and Industrial Development Board for that area. New and expanding industries are expected to provide additional employment for 35,506 men and women.

Coal Production Improves

Despite the continued decline in manpower, output of coal in Great Britain last week showed a further small rise, the total of 4,358,800 tons comparing with 4,343,100 tons in the previous week and 4,295,400 tons in the corresponding week of 1949. In the first seven weeks of this year 29,989,500 tons were raised, an increase of 566,400 tons on the same period last year.

Twenty-six Women Pharmacists

Thirteen women have become qualified pharmacists at this month's examinations of the Pharmaceutical Society in Scotland. The same number qualified at the corresponding examinations in England. Thirty-four men were successful.

New Factory for Seaweed Products

A factory for the manufacture of dried pulverised fertilisers, animal feed, etc., is to be set up near Nairn, Scotland, by Seaweed Products, Ltd. At the company's temporary premises at Ardersier, in the same district, only cattle and pig food is at present being produced.

Penicillin Price Reduction

The sixth reduction in the price of penicillin, since supplies were made freely available in 1946, has been announced by Glaxo Laboratories, Ltd. This brings the price of crystalline penicillin to the same level as that of the amorphous (yellow) variety.

Damage at I.C.I. Plant

An outbreak of fire in an oleum plant in a shed at the Dalton works of I.C.I., Ltd., Huddersfield, this week, was extinguished in about half an hour by the local and works fire brigades after damage had been done to the plant and the roof of the building.

N.C.B. University Scholarships

For the third successive year the National Coal Board is offering scholarships for degree courses, mainly in mining subjects, for which applications are already being received. Of the 100 scholarships offered, five are under a scheme for Fuel Technology Scholarships offered by the British Coking Industry Association. The awards are worth up to £300 a year, and there is an additional allowance for married men.

Consultation for Coke Oven Workers

A joint consultative council for all employees in that part of the coke oven and by-products industry which has vested in the National Coal Board was set up in London on February 15. It will operate on lines similar to that existing in the mining industry and will affect about 7000 coke oven and by-product workers at 52 plants. The Coke Oven National Consultative Council is composed of representatives of the board, the Coke Oven Managers' Association, and the National Union of Mineworkers.

Next Week's Events

MONDAY, FEBRUARY 27

The Chemical Society

Oxford: Physical Chemistry Laboratory, 8.15 p.m. Sir John Lennard-Jones: "Some Unifying Concepts in Chemistry."

Institution of Works Managers

Glasgow: 39 Elmbank Crescent, C.2, 7 p.m. Dr. S. I. A. Laidlaw: "Occupational Health as a Part of the Provisions of a Public Health Department."

TUESDAY, FEBRUARY 28

The Society of Instrument Technology

London: Manson House, Portland Place, W.1, 7 p.m. Dr. H. Spencer Gregory and E. Rourke: "Some Modern Aspects of Hygrometry."

WEDNESDAY, MARCH 1

The Chemical Society

Eire, Dublin: University College, 7.45 p.m. (with ICA, RIC and SCI). Prof. M. Stacey: "Deoxy-sugars and Nucleic Acids." (Also at University College, Cork, 7.45 p.m., Friday, March 3.)

Manchester Metallurgical Society

Manchester: Engineers' Club, Albert Square, 6.30 p.m. Dr. J. W. Cuthbertson: "Continuous Casting of Metals."

THURSDAY, MARCH 2

The Chemical Society

London: Imperial College of Science and Technology, S.W.7, 7.15 p.m. Prof. Dr. Pl. A. Plattner: "The Azulenes."

Hull: University College, 6 p.m. (with RIC). Dr. G. M. Bennett: "Aromatic Nitration."

The Royal Society

London: Burlington House, Piccadilly, W.1, 4.30 p.m. E. C. Childs: "The Permeability of Porous Materials." C. Kemball: "The Adsorption of Vapours on Mercury"—IV. (Surface Potentials and Chemisorption).

The Institute of Metals

Birmingham: James Watt Memorial Institute, Great Charles Street, 6.30 p.m. Discussion: "Some Modern Aspects of Welding."

FRIDAY, MARCH 3

The Chemical Society

Manchester: University, 6.30 p.m. Prof. Dr. Pl. A. Plattner: "The Azulenes."

Southampton: University College, 5 p.m. Dr. H. Irving: "The Determination of Traces of Elements and Compounds."

Swansea: University College, 5.30 p.m. Prof. F. E. King: "Synthetic Investigations in the Series of Cyclic Imines."

The Royal Institute of Chemistry

London: Woolwich Polytechnic, S.E.18, 7.30 p.m. Dr. N. Booth: "Careers for Chemists."

SATURDAY, MARCH 4

The British Interplanetary Society

London: Caxton Hall, S.W.1, 6 p.m. H. F. Zumpe: "Testing of Rocket Motors."

The Association of Scientific Workers

London: St. Pancras Town Hall, Euston Road, N.W.1, 2.30 p.m. Conference: "The World's Food and Britain's Needs."

Electrodepositors' Jubilee

PLANS for the special conference and celebrations to mark the silver jubilee of the Electrodepositors' Technical Society have now been announced in a brochure presenting the programme to be followed at the Grand Hotel, Eastbourne, Wednesday, April 19, to Saturday, April 22.

During five technical sessions there will be presented a wide range of papers and discussions. Mr. A. W. Wallbank, president, will be chairman at the opening session on Thursday, which will be devoted to electropolishing. The second session (2 to 4.30 p.m. the same day) will be concerned with alloy deposition.

Miscellaneous papers will occupy the third session on Friday morning, when the chair will be taken by Mr. R. C. Davies, chairman, Midlands centre. The fourth session in the afternoon will be under the chairmanship of F. Mason, chairman, Sheffield and North-East centre, and will be divided into two parts, one on metal cleaning and the other a discussion on education in the electroplating industry.

The technical programme finishes on Saturday morning with a discussion on the interpretation of specifications.

Chemical Engineers Meet

THE 28th annual corporate meeting of the Institution of Chemical Engineers will be held at the May Fair Hotel, London, on Friday, April 14. During the morning business session presentations of medals will be made.

"Technology and the State" will be the subject of the presidential address to be given by Professor D. M. Newett at 12 noon. The annual dinner will be at 7 p.m.

Law and Company News

Commercial Intelligence

The following are taken from the printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described herein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary but such total may have been reduced.)

COPPER & ALLOYS, LTD., West Bromwich. (M., 25/2/50.) January 23, £165,000 charge (further increasing limit secured by a charge dated July 19, 1940, etc., from £360,000 to £525,000), to N. M. Rothschild & Sons, London; general charge. *£370,000. July 25, 1949.

PETROCHEMICALS, LTD., London, W. (M., 25/2/50.) January 18, £2,500,000 second secured loan stock with a premium of 5 per cent, secured by a trust deed dated December 30, 1949; charged on properties, benefit of an agreement for lease, certain shares, and a general charge. *£1,300,000. February 22, 1949.

WESTERN OXIDE & PAINT CO., LTD., Plymouth. (M., 25/2/50.) January 19, £5000 second mortgage, to Smith & Walton, Ltd.; charged on premises and land known as Commercial Yard, Sutton Road, Plymouth. *Nil. January 13, 1949.

Increases of Capital

The following increases of registered capital have been announced: Cloister Laboratories, Ltd., from £10,000 to £15,000. Maurice D. Curwen, Ltd., from £1000 to £10,000. Domestos, Ltd., from £7000 to £250,000. Marchon Products, Ltd., from £2000 to £100,000. Thomas Shepherd & Co., Ltd., from £20,000 to £30,000. Evans Medical Supplies, Ltd., from £450,000 to £1,000,000.

Company News

Etablissements Kuhlmann

The leading French producer of chemicals and dyestuffs has increased its capital, by drawing upon reserves, from Fr. 2196 million to 2745 million.

New German Export Company

The Eisen-und Stahl Export, G.m.b.H., Stahlex, has recently been formed in Düsseldorf to trade in iron, steel, ores and machinery. It is reported to have established contacts with Bishopsgate Steels, Ltd., London, and the Transcontinental Steel Inc., of New York and Brussels.

New Registrations

A. B. Rosen, Ltd.

Private company. (478,370). Capital £2000. Manufacturers of chemicals, disinfectants, soaps, washing materials, etc. Directors: A. B. Rosen and P. Rosen. Reg. office: El-Dor Works, Abbey Street, Northampton.

Hindshaw, Lester (Dyestuffs), Ltd.

Private company. (478,437). Capital £3000. Manufacturers of dyes, dyestuffs, dyeware, chemicals, fine chemicals and chemical products, etc. Directors: F. Hindshaw, H. M. Lester. Reg. office: Parsonage Buildings, 4 St. Mary's Parsonage, Manchester, 3.

Australian Wire and Tube

PLANS for large expansion of Metal Manufacturers, Ltd., the Australian company with many subsidiaries, are expected to result in considerable development of related secondary industries—states the Australian News and Information Bureau. New imported wire drawing plant will double production of copper wire and strand during 1950. At Port Kembla, New South Wales, a new rod rolling mill will produce 40,000 tons by the end of the year. Copper and brass tubes used in industries will be produced at the rate of 75 million ft. a year. Much of the copper required will be derived from South Africa.

Large-Scale Injection Moulding

THE principle of large-scale injection moulding of polythene is now being successfully applied by an Australian company (Industrial Products, of Adelaide) which is producing large plastic jars for the storage of chemicals. They are the largest injection mouldings in Australia and employ a special press built for the purpose. Three-and-a-half pounds of the material is shot in each operation. The whole jar, except the bottom, which is heat welded afterwards, is made in a single operation. Jars hold three-and-a-half gallons.

Chemical and Allied Stocks and Shares

ALTHOUGH best levels were not entirely held, stock markets were buoyant and more active, with British Funds higher on balance and widespread gains in industrials. Following earlier gains, there was an appreciable amount of profit-taking in shares of companies threatened with nationalisation, but, at the time of writing, buyers have come in at the lower levels.

A change of Government, it is believed in the City, would bring modification of dividend limitation and perhaps abolition of the ban on share bonuses. There has consequently been increased demand for many industrial shares. It is realised, nevertheless, that in the event of Labour victory share values would probably suffer a general set-back from the recently improved levels.

Reflecting the general tendency, shares of chemical and allied companies have been more active and mostly higher where changed, although best levels have not been held. Imperial Chemical touched 44s., before easing to 43s. 9d., Monsanto have been firm at 50s. 7½d., and Fisons steadier at 22s. 9d. Albright & Wilson changed hands around 28s. 9d., F. W. Berk 2s. 6d. shares were 13s. 7½d., and William Blythe 3s. shares were dealt in at 9s. Brotherton were 19s. 4½d., and Lawes Chemical marked 9s. 9d.

Laporte Chemicals 5s. units again transferred around 9s. 4½d., and British Glues 4s. shares were strong at 20s. 9d. Turner & Newall at 81s. lost part of an earlier rise, and Associated Cement at 77s. 9d. also came in for some profit-taking, although buying was at the lower levels.

Shares of companies connected with plastics strengthened, notably British Xylonite (65s.) while British Industrial Plastics 2s. shares firmed up to 5s., and Erinoid were 6s. 7½d. Elsewhere, British Oxygen were 94s. 6d., British Aluminium were firm at 40s. 9d., and General Refractories well maintained at 23s. The 4s. units of the Distillers Co. were little changed at 17s. 7½d. United Molasses were 40s. 6d., and Triplex Glass rose to 19s. 3d.

Borax Consolidated deferred, at 54s. 6d., have remained quiet. Improvement in Amalgamated Metal shares to 18s. 7½d. reflected hopes that the result of the General Election will mean resumption of "free" dealings on the London Metal Exchange in zinc, lead and other base metals.

Iron and steels remained more active and were generally higher. Stewarts & Lloyds were 55s. 3d., United Steel 27s. 10½d., and Richard Thomas 14s. 1½d. Elsewhere, Staveley changed hands around 78s. 3d.

Glaxo Laboratories strengthened to 45s., Lever & Unilever were better at 43s., and Boots Pure Drug rose to 49s.

Paints have attracted more attention, Lewis Berger 4s. units being 27s. as a result of the company's assets segregation scheme. Pinchin Johnson were better at 39s. 1½d.

Oils have remained unsettled, awaiting further developments arising from Britain's decision to reduce oil imports from the dollar countries. Anglo-Iranian at a little over £7 were, however, slightly higher on balance.

U.S. Synthetic Pyrethrum

SYNTHESIS of a group of chemicals closely corresponding with natural pyrethrum was announced in the U.S.A. by the United States Department of Agriculture early last year.

Foreign rights to the pending U.S. patents covering these pyrethrum-like insecticidal chemicals have now been acquired by United States Industrial Chemicals, Inc. Corresponding applications have been filed in Great Britain, Australia, India, Pakistan, South Africa, Brazil, France, Sweden and many other countries. In America the patents are held in the public interest for unrestricted use.

Preparation of Seaweed

An improved method for the preliminary treatment of seaweed intended for the production of chemical products is the subject of a new English patent (No. 633,798) by J. A. Kelly, of Kilrush, Co. Clare. Sun-dried seaweed—mostly stalks—is cut into fragments and then further dried artificially. The crushing may be done between rollers and the strips thus flattened are more easily cut by any known system, *e.g.*, adapted to act transversely on strips alternately in opposite directions. When thus cut into particles of wheat grain size they are further dried by known methods, e.g., by heated dehydrator, so that moisture content is reduced to 10-12 per cent. Varieties of seaweed mentioned as examples are *Laminaria digitata* and *L. clustonii.*

Prices of British Chemical Products

Improving Level of Demand in the North

THE general position in the industrial chemicals market remains almost the same as reported last week. Apart from an active seasonal inquiry for insecticides and fertilisers, and perhaps for items such as chlorate of soda, buyers appear to be temporising until the results of the General Election are known. Contract deliveries are being taken up according to schedule and the volume of overseas inquiry is fully maintained. There have been few price alterations of any importance and quotations in all sections of the market, including the coal tar products, continue steady. Business in the latter is of moderate dimensions and most items are in plentiful supply.

MANCHESTER.—A firm undertone persists in virtually all sections of the Manchester market for heavy chemicals, although actual movements had been few and unimportant. Delivery specifications of textile and other industrial chemicals have covered substantial aggregate quantities and fresh home trade bookings have been on a fair scale. There is a steady movement of supplies on export account. A better demand for superphosphates and other fertilisers has been reported, and most of the tar products have received a fair amount of attention, a steady outlet for xylols and other distillates being reported.

GLASGOW.—The recent increase in turnover in the Scottish chemical market has been maintained during the past week. Over the last few months there has been a steady increase in consumption of all chemicals used in plating. A number of new plating firms have been opened and, in addition, there are several in the new industrial estates which have their own plating shops. The demand for xylol and toluol has also been increasing, but there are a number of factories which cannot get into full production owing to the comparative shortage of these materials. With the new industries planned or in the course of construction in Scotland, there is every indication that the demand for chemicals will continue to rise steadily.

Price Changes

Rises: *p*-Nitraniline, salicylic acid.

Reductions: Lead, litharge, pyridine, toluol, zinc oxide.

General Chemicals

Acetic Acid.—Per ton: 80% technical, 1 ton, £61; 80% pure, 1 ton, £66; commercial glacial 1 ton £71; delivered buyers' premises in returnable barrels; in glass carboys, £7; demijohns, £11 extra.

Acetic Anhydride.—Ton lots d/d, £110 per ton.

Acetone.—Small lots: 5 gal. drums, £90 per ton; 10 gal. drums, £85 per ton. In 40/45 gal. drums less than 1 ton, £70 per ton; 1 to 9 tons, £69 per ton; 10 to 50 tons, £68 per ton; 50 tons and over, £67 per ton.

Alcohol, Industrial Absolute.—50,000 gal. lots, d/d, 2s. 1d. per proof gallon; 5000 gal. lots, d/d, 2s. 2½d. per proof gal.

Alcohol, diacetone.—Small lots: 5 gal. drums, £133 per ton; 10 gal. drums, £128 per ton. In 40/45 gal. drums: less than 1 ton, £113 per ton; 1 to 9 tons, £112 per ton; 10 to 50 tons, £111 per ton; 50 to 100 tons, £110 per ton; 100 tons and over, £109 per ton.

Alum.—Loose lump, £17 per ton, f.o.r. MANCHESTER: Ground, £17 10s.

Aluminium Sulphate.—Ex works, £11 10s. per ton d/d. MANCHESTER: £11 10s.

Ammonia, Anhydrous.—1s. 9d. to 2s. 3d. per lb.

Ammonium Bicarbonate.—2 cwt. non returnable drums; 1 ton lots £40 per ton.

Ammonium Carbonate.—1 ton lots; MANCHESTER: Powder, £52 d/d.

Ammonium Chloride. — Grey galvanising, £27 10s. per ton, in casks, ex wharf. Fine white 98%, £21 10s. to £22 10s. per ton. See also Salammoniac.

Ammonium Nitrate.—D/d, £18 to £20 per ton.

Ammonium Persulphate.—MANCHESTER: £5 per cwt. d/d.

Ammonium Phosphate.—Mono- and di-, ton lots, d/d, £78 and £76 10s. per ton.

Amyl Acetate.—In 10-ton lots, £171 10s. per ton.

Antimony Oxide.—£140 per ton.

Antimony Sulphide.—Golden, d/d in 5 cwt. lots, as to grade, etc., 1s. 9½d. to 2s. 4¾d. per lb. Crimson, 2s. 6¼d. to 3s. 3½d. per lb.

Arsenic.—Per ton, £38 5s. to £41 5s., ex store.

Barium Carbonate.—Precip., d/d; 2-ton lots, £27 5s. per ton, bag packing, ex works.

Barium Chloride.—£35 to £35 10s. per ton.

Barium Sulphate (Dry Blanc Fixe).—Precip., 4-ton lots, £29 10s. per ton d/d; 2-ton lots, £29 15s. per ton.

Bleaching Powder.—£25 15s. per ton in casks (1 ton lots).

Borax.—Per ton for ton lots, in free 140 lb. bags, carriage paid: Anhydrous, £54; in 1-cwt. bags, commercial, granular, £34 10s.; crystal, £37; powder, £38, extra fine powder, £39; B.P., granular, £44; crystal, £46; powder, £48-£48 10s.; extra fine powder £48.

Boric Acid.—Per ton for ton lots in free 1-cwt. bags, carriage paid: Commercial, granular, £62; crystal, £69; powder, £66 10s.; extra fine powder, £68 10s.; B.P., granular, £75 10s.; crystal, £81; powder, £78 10s.; extra fine powder, £80 10s.

Butyl Acetate BSS.—£149 10s. per ton, in 10-ton lots.

Butyl Alcohol BSS.—£145 10s per ton, in 10-ton lots.

Calcium Bisulphide.—£6 10s. to £7 10s. per ton f.o.r. London.

Calcium Chloride.—70/72% solid £8 per ton, in 4 ton lots.

Charcoal, Lump.—£25 per ton, ex wharf. Granulated, £30 per ton.

Chlorine, Liquid.—£28 10s. per ton d/d in 16/17-cwt. drums (3-drum lots).

Chrometan.—Crystals, 6d. per lb.

Chromic Acid.—1s. 10d. to 1s. 11d. per lb., less 2½%, d/d U.K.

Citric Acid.—Controlled prices per lb., d/d buyers' premises. For 5 cwt. or over, anhydrous, 1s. 6¾d., other, 1s. 5d.; 1 to 5 cwt., anhydrous, 1s. 9d., other, 1s. 7d. Higher prices for smaller quantities.

Cobalt Oxide.—Black, delivered, 8s. 5d. per lb.

Copper Carbonate.—MANCHESTER: 1s. 7d. per lb.

Copper Chloride.—(53 per cent), d/d, 1s. 11½d. per lb.

Copper Oxide. — Black, powdered, about 1s. 4½d. per lb.

Copper Nitrate.—(53 per cent), d/d, 1s. 10d. per lb.

Copper Sulphate.—£47 5s. per ton f.o.b., less 2%, in 2-cwt. bags.

Cream of Tartar.—100%, per cwt., about £7 8s. per 1-2 cwt. lot, d/d.

Ethyl Acetate.—10 tons and upwards, d/d, £103 10s. per ton.

Formaldehyde.—£31 per ton in casks, according to quantity, d/d. MANCHESTER: £32.

Formic Acid.—85%, £64 per ton for ton lots, carriage paid. 90%, £67 5s. per ton.

Glycerine.—Chemically pure, double distilled 1260 s.g. £123 per cwt. Refined pale straw industrial, 5s. per cwt. less than chemically pure.

Hexamine.—Technical grade for commercial purposes, about 1s. 4d. per lb.; free-running crystals are quoted at 2s. 1d. to 2s. 3d. per lb.; bulk carriage paid.

Hydrochloric Acid.—Spot, 7s. 6d to 8s 9d. per carboy d/d, according to purity, strength and locality.

Hydrofluoric Acid.—59/60%, about 1s. to 1s. 2d. per lb.

Hydrogen Peroxide.—1s. 0½d. per lb. d/d, carboys extra and returnable.

Iodine.—Resublimed B.P., 10s. 4d. to 14s. 6d. per lb., according to quantity.

Iron Sulphate.—F.o.r. works, £3 15s. to £4 per ton.

Lactic Acid.—Pale, tech., £80 per ton; dark tech., £70 per ton ex works; barrels returnable.

Lead Acetate.—White, £107 per ton. (Nominal.)

Lead Carbonate.—British dry, ton lots, d/d, £115 10s. (Nominal.)

Lead Nitrate.—About £116 per ton d/d in casks.

Lead, Red.—Basis prices per ton: Genuine dry red lead, £115 5s., orange lead, £127 15s. Ground in oil: red, £137 5s., orange, £149 5s.

Lead, White.—Basis prices: Dry English, in 8-cwt. casks, £124 5s. per ton, Ground in oil, English, under two tons, £143 5s.

Lime Acetate.—Brown, ton lots, d/d, £18 to £20 per ton; grey, 80-82 per cent, ton lots, d/d. £22 to £25 per ton.

Litharge.—£115 15s. per ton.

Lithium Carbonate.—7s. 9d. per lb. net.

Magnesite.—Calcined, in bags, ex works, £27.

Magnesium Carbonate.—Light, commercial, d/d, £70 per ton.

Magnesium Chloride.—Solid (ex wharf), £20 to £25 per ton.

Magnesium Oxide.—Light, commercial, d/d, £160 per ton.

Magnesium Sulphate.—£12 to £14 per ton.

Mercuric Chloride.—Per lb., lump, 7s. 4d.; smaller quantities dearer.

Mercurous Chloride.—8s. to 9s. per lb., according to quantity.

Mercury Sulphide, Red.—Per lb., from 10s. 3d. for ton lots and over to 10s. 7d. for lots of 7 to under 30 lb.

Methanol.—Pure synthetic, d/d, £28 to £38 per ton.

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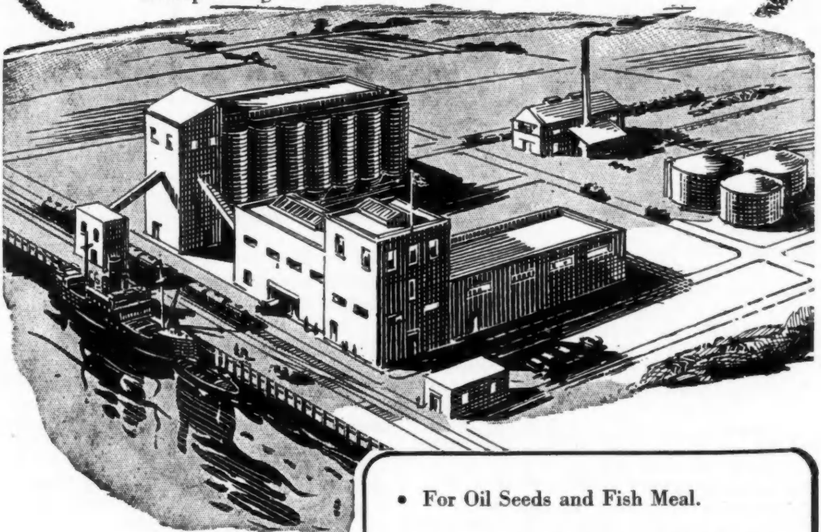

Methylated Spirit.—Industrial 66° O.P. 100 gals., 3s. 7½d. per gal.; pyridinised 64° O.P. 100 gal., 3s. 8½d. per gal.

Nickel Sulphate.—F.o.r. works, 3s. 4d. per lb. (Nominal.)

Nitric Acid.—£24 to £26 per ton, ex works.

Oxalic Acid.—£128 to £133 per ton packed in free 5-cwt. casks.

Paraffin Wax.—From £61 10s. to £101 17s. 6d., according to grade for 1 ton lots.

Phosphoric Acid.—Technical (S.G. 1.500), ton lots, carriage paid, £61 per ton; B.P. (S.G.1.750), ton lots, carriage paid, 1s. 1d. per lb.

Phosphorus.—Red, 3s. per lb. d/d; yellow, 1s. 10d. per lb. d/d.

Potash, Caustic.—Solid, £65 10s. per ton for 1-ton lots; flake, £76 per ton for 1-ton lots. Liquid, d/d, nominal.

Potassium Bichromate. — Crystals and granular, 9⅝d. per lb.; ground, 10⅝d. per lb., for not less than 6 cwt.; 1-cwt. lots, ½d. per lb. extra.

Potassium Carbonate.—Calcined, 98/100%, £64 per ton for 1-ton lots, ex store; hydrated, £58 for 1-ton lots.

Potassium Chlorate.—Imported powder and crystals, nominal.

Potassium Chloride.—Industrial, 96 per cent, 6-ton lots, £16.10 per ton.

Potassium Iodide.—B.P., 11s. 1d. to 12s. per lb., according to quantity.

Potassium Nitrate.—Small granular crystals, 76s. per cwt. ex store, according to quantity.

Potassium Permanganate.—B.P., 1s. 7½d. per lb. for 1-cwt. lots; for 3 cwt. and upwards, 1s. 6d. per lb.; technical, £7 9s. 6d. to £8 3s. 0d. per cwt.; according to quantity d/d.

Potassium Prussiate.—Yellow, nominal.

Salammoniac.—Dog-tooth crystals, £72 10s per ton; medium, £67 10s. per ton; fine white crystals, £21 10s. to £22 10s. per ton, in casks.

Salicylic Acid.—MANCHESTER: 1s. 11d. to 3s. 2d. per lb. d/d.

Soda Ash.—58° ex depôt or d/d, London station, £7 12s. 6d. to £8 7s. 6d. per ton.

Soda, Caustic. — Solid 76/77%; spot, £20 14s. per ton d/d.

Sodium Acetate.—£41-£55 per ton.

Sodium Bicarbonate.—Refined, spot, £11 per ton, in bags.

Sodium Bichromate.—Crystals, cake and powder, 8d. per lb.; anhydrous, 7½d. per lb., net, d/d U.K. in 7-8 cwt. casks.

Sodium Bisulphite. — Powder, 60/62%, £29 12s. 6d. per ton d/d in 2 ton lots for home trade.

Sodium Carbonate Monohydrate.—£25 per ton d/d in minimum ton lots in 2-cwt. free bags.

Sodium Chlorate.—£52 to £57 per ton.

Sodium Cyanide.—100 per cent basis, 8d. to 9d. per lb.

Sodium Fluoride.—D/d, £4 10s. per cwt.

Sodium Hyposulphite. — Pea crystals £23 2s. 6d. a ton; commercial, 1-ton lots, £21 12s. 6d. per ton carriage paid.

Sodium Iodide.—B.P., 10s. 2d. per lb. to 12s. 1d. according to quantity.

Sodium Metaphosphate (Calgon).—Flaked, loose in metal drums, £101 10s. ton.

Sodium Metasilicate.—£19 to £19 5s. per ton, d/d U.K. in ton lots.

Sodium Nitrate.—Chilean Industrial, 97-98 per cent, 6-ton lots, d/d station, £20 10s. per ton.

Sodium Nitrite.—£29 10s. per ton.

Sodium Percarbonate.—12½% available oxygen, £7 16s. 9d. per cwt. in 1-cwt. drums.

Sodium Phosphate.—Per ton d/d for ton lots: Di-sodium, crystalline, £32 10s., anhydrous, £65; tri-sodium, crystalline, £32 10s., anhydrous, £62.

Sodium Prussiate.—9d. to 9½d. per lb. ex store.

Sodium Silicate.—£6 to £11 per ton.

Sodium Silicofluoride.—Ex store, nominal.

Sodium Sulphate (Glauber Salt).—£8 per ton d/d.

Sodium Sulphate (Salt Cake).—Unground. £6 per ton d/d station in bulk. MANCHESTER: £6 10s. per ton d/d station.

Sodium Sulphide. — Solid. 60/62%, spot. £24 10s. per ton, d/d, in drums; broken, £25 5s. per ton, d/d, in casks.

Sodium Sulphite.—Anhydrous, £29 10s. per ton; pea crystals, £20 10s. per ton d/d station in kegs; commercial, £12 to £14 per ton d/d station in bags.

Sulphur.—Per ton for 4 tons or more, ground, £15 11s. 6d. to £17 16s. 6d. according to fineness.

Sulphuric Acid.—168° Tw., £6 2s. to £7 2s. per ton; 140° Tw., arsenic free £4 18s. 6d. per ton; 140° Tw., arsenious, £4 11s. per ton. Quotations naked at sellers' works.

Tartaric Acid.—Per cwt: 10 cwt. or more £8 10s.; 5 to 9 cwt. £8 12s.; 2 to 4 cwt. £8 14s.; 1 cwt. £8 16s.

Tin Oxide.—1-cwt. lots d/d £25 10s. (Nominal.)

Titanium Oxide.—Comm., ton lots, d/d, (56 lb. bags) £102 per ton.

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Zinc Oxide.—Maximum price per ton for 2-ton lots, d/d; white seal, £84 15s. green seal, £83 15s.; red seal, £82 5.

Zinc Sulphate.—Nominal.

Rubber Chemicals

Antimony Sulphide.—Golden, 4s. to 5s. per lb. Crimson, 2s. 7½d. to 3s. per lb.

Arsenic Sulphide.—Yellow, 1s. 9d. per lb.

Barytes.—Best white bleached, £11-£11 10s. per ton.

Cadmium Sulphide.—6s. to 6s. 6d. per lb.

Carbon Bisulphide.—£37 to £41 per ton, according to quality, in free returnable drums.

Carbon Black.—6d. to 8d. per lb., according to packing.

Carbon Tetrachloride.—£56 to £59 per ton, according to quantity.

Chromium Oxide.—Green, 2s. per lb.

India-rubber Substitutes.—White, 10 5/16d. to 1s. 5¾d. per lb.; dark, 10¼d. to 1s. per lb.

Lithopone.—30%, £36 15s. per ton.

Mineral Black.—£7 10s. to £10 per ton.

Mineral Rubber, "Rupron."—£20 per ton.

Sulphur Chloride.—7d. per lb.

Vegetable Lamp Black.—£49 per ton.

Vermillion.—Pale or deep, 15s. 6d. per lb. for 7-lb. lots.

Nitrogen Fertilisers

Ammonium Sulphate.—Per ton in 6-ton lots, d/d farmer's nearest station, in January £10 8s., rising by 1s. 6d. per ton per month to March, 1950.

Compound Fertilisers.—Per ton d/d farmer's nearest station, I.C.I. No. 1 grade, where available, £10 14s. 6d. I.C.I. Special No. 1, £16 3s. 6d., rising by 2s. 6d. per ton per month to June, 1950. National No. 2, £10 18s. per ton.

"Nitro-Chalk."—£10 4s. per ton in 6-ton lots, d/d farmer's nearest station.

Sodium Nitrate.—Chilean for 6-ton lots d/d nearest station, £11 per ton.

Coal-Tar Products

Benzol.—Per gal. ex works: 90's, 2s. 6d.; pure, 2s. 8½d.; nitration grade, 2s. 10½d.

Carbolic Acid.—Crystals, 10¾d. to 1s. 0½d. per lb. Crude, 60's, 4s. 3d. MANCHESTER: Crystals, 10¾d. to 1s. 0½d. per lb., d/d crude, 4s. 3d., naked, at works.

Creosote.—Home trade, 6¼d. to 9¾d. per gal., according to quality, f.o.r. maker's works. MANCHESTER: 6¼d. to 9¾d. per gal.

Cresylic Acid.—Pale, 98%, 3s. 9d per gal.; 99%, 3s. 1d.; 99.5/100%, 4s. 4d. American, duty free, 4s. 2d., naked at works. MANCHESTER: Pale, 99/100%, 3s. 11d. per gal.

Naphtha.—Solvent, 90/160°, 2s. 10d. per gal. for 1000-gal. lots; heavy, 90/190°, 2s. 4d. per gal. for 1000-gal. lots, d/d. Drums extra; higher prices for smaller lots. Controlled prices.

Naphthalene.—Crude, ton lots, in sellers' bags, £8 1s. to £12 13s. per ton according to m.p.; hot-pressed, £14 15s. to £15 14s. per ton, in bulk ex works; purified crystals, £28 to £43 5s. per ton. Controlled prices.

Pitch.—Medium, soft, home trade, 100s. per ton f.o.r. suppliers' works; export trade, £6 to £7 per ton f.o.b. suppliers' port. MANCHESTER: £5 10s. f.o.r.

Pyridine.—90/140°, 22s. to 23s. per gal.; 90/160°, 21s. MANCHESTER: 19s. to 22s. per gal.

Toluol.—Pure, 3s. 2d. per gal.; 90's, 2s. 4d. per gal. MANCHESTER: Pure, 3s. 2d. per gal. naked.

Xylol.—For 1000-gal. lots, 3s. 3½d. to 3s. 6d. per gal., according to grade, d/d.

Wood Distillation Products

Calcium Acetate.—Brown, £15 per ton; grey, £22.

Methyl Acetone.—40/50%, £56 to £60 per ton.

Wood Creosote.—Unrefined, from 3s. 6d. per gal., according to boiling range.

Wood Naphtha.—Miscible, 4s. 6d. to 5s. 6d. per gal.; solvent, 5s. 6d. to 6s. 6d. per gal.

Wood Tar.—£6 to £10 per ton.

Intermediates and Dyes (Prices Nominal)

***m*-Cresol** 98/100%.—Nominal.

***o*-Cresol** 30/31° C.—Nominal.

***p*-Cresol** 34/35° C.—Nominal.

Dichloraniline.—2s. 8½d. per lb.

Dinitrobenzene.—8½d. per lb.

Dinitrotoluene.—48/50° C., 9½d. per lb.; 66/68° C., 1s.

***p*-Nitraniline.**—2s. 11d. per lb.

Nitrobenzene.—Spot, 5½d. per lb. in 90-gal. drums, drums extra, 1-ton lots d/d buyers' works.

Nitronaphthalene.—1s. 2d. per lb.; P.G. 1s. 0½d. per lb.

***o*-Toluidine.**—1s. per lb., in 8/10-cwt. drums, drums extra.

***p*-Toluidine.**—2s. 2d. per lb., in casks.

***m*-Xylidine Acetate.**—4s. 5d. per lb., 100%.

Latest Oil Prices

LONDON: February 23. The prices of all refined oils and fats are subject to revision on February 25. The prices of all unrefined oils and fats remain unchanged during the four-week period ending March 4.

BALKAN TRADE PENDING

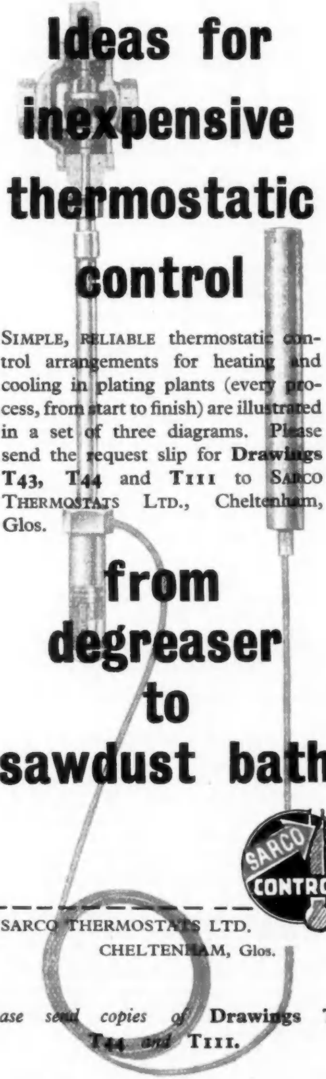
THE inclusion of substantial shipments of a wide range of chemical materials under current agreement between this country and Czechoslovakia is foreshadowed in an article by the British First Secretary (Commercial) in Prague in the current *Board of Trade Journal* (No. 2774, 353). This recalls that Czechoslovakia has been assured of a sterling supply of rather more than £7 million annually for the purchase of machinery and raw materials.

About £1.5 million will be allocated to the purchase in this country of 40 or 50 commodities. The most important of these, records the First Secretary, are synthetic resins and solvents for the lacquer industry, anti-oxidants and accelerators for the rubber industry, colours based on metallic and non-metal oxides, contractors' plant, artificial silk, pharmaceutical and laboratory raw materials, cotton yarn and aniline dyestuffs; for each of which a quota of £50,000 or more has been fixed.

The remaining £5 or £5½ million which Czechoslovakia may hope to have will be used in all probability for the purchase of machinery, parts and raw materials.

£2.25 m. Coke-Oven Contract

A contract to manufacture and install 88 ovens for coal and coke handling and by-product plant at a Flintshire steelworks has been secured by Simon-Carves, Ltd., Cheadle Heath, near Manchester. The contract is valued at £2.25 million, and the plant will be capable of treating 1600 tons of coal a day.



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SITUATIONS VACANT

None of the vacancies in these columns relates to a man between the ages of 18 and 50 inclusive, or a woman between the ages of 18 and 40 inclusive, unless he or she is exempted from the provisions of the Control of Engagement Order, or the vacancy is for employment exempted from the provisions of that order

UGANDA CEMENT INDUSTRY

CHIEF CHEMIST required for new cement factory in Uganda. Should have sound scientific training and industrial experience. Experience in cement manufacture advantageous. Salary, £1,000 to £1,500 per year according to qualifications. Good prospects of advancement, possibly to managership. Three-year engagement in first place. Free accommodation and medical attention. Home leave and paid passages. Healthy climate. Moderate income tax. **Applications to Uganda Electricity Board, 129, Grand Buildings, Trafalgar Square, London, W.C.2.**

CHEMICAL ENGINEERS. The Midland Tar Distillers Ltd., Oldbury, Nr. Birmingham, require two experienced Chemical Engineers, aged about 30, for design work, pilot plant operation, plant development work, etc. A Degree in Chemical Engineering or A.M.I.Chem.E. essential. Similar experience in the oil-refining industry is an advantage but is not essential. Applicants should possess initiative and persistence. Applications to **Personnel Manager.**

PATENTS & TRADE MARKS

KING'S PATENT AGENCY, LTD. (B. T. King, A.M.I.Mech.E., Patent Agent), 146a, Queen Victoria Street, London, E.C.4. ADVICE Handbook, and Consultation free. Phone: City 6161.

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DRYING INSTALLATION by **MANLOVE ALLIOTT,** comprising rotary drum, 60 ft. long by 8 ft. diam. gearing, dust fan and two cyclones.

Silex lined **BALL MILL** by **FRASER & CHALMERS,** 4 ft. 6 in. long by 3 ft. 6 in. diam. int. Continuous type, driven from F. and L. pulley through main gear and pinion.

Plate and frame **FILTER PRESS** by **DEHNE,** 16 frames, 2 ft. 5 in. by 2 in. thick, washing type with individual discharge to each frame if required. Complete with pump.

Battery of 16 vacuum **DRYING OVENS** arranged in 8 pairs, each oven constructed from $\frac{3}{16}$ M.S. welded plate, 4 ft. 7 in. wide, 3 ft. $4\frac{1}{2}$ in. high by 3 ft. $6\frac{1}{2}$ in. deep. Sliding door operated by counter balance weights. 12 steam heated shelves arranged in three rows of four, w.p. 5 lb. sq. in. Included is Nash Lytor vacuum pump size H4 motorised 400/3/50.

Two direct electrically under-driven **HYDRO EXTRACTORS** by **THOS. BROADBENT,** three point suspension, pit type, with 72 in. diam. galvanised perforated basket. Hand operated brake, non-interlocking wire mesh cover. Motorised 400/3/50.

Size 7 duplex **MIXING OR KNEADING MACHINE** by **MORTON** of Wishaw. Steam jacketed trough approx. 42 in. by 38 in. by 30 in. deep, cap. 115 gals. Double Naben type twin gunmetal mixing blades. Int. w.p. 15 lb. sq. in. or high vacuum. Power operated tilting.

Three unused stainless steel vert. open top steam jacketed **MIXERS** by **BRIERLEY COLLIER & HARTLEY.** Pans, 18 in. diam. by 10 in. deep, 15 lb. sq. in. w.p. Stainless steel agitator attached to rise and fall head.

Horiz. **MIXER** by **KRUPP** approx. inter. dimensions, 5 ft. by 5 ft. by 5 ft. Non-tilting double trough with heavy twin "Z" blades, bottom discharge along apex formed by troughs at present driven by 50 h.p. D.C. motor.

GEORGE COHEN, SONS & CO., LTD., SUNBEAM ROAD, LONDON, N.W.10.

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ALUMINIUM VACUUM CHAMBERS. One 36 in. by 25 in. by 23 in. inside dimensions. Two 18 in. by 10 in. by 10 in. inside dimensions. Fitted glass inspection panels. Good condition.

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BROADBENT 48-in. SUSPENDED TYPE HYDRO EXTRACTOR, overdriven from 15 h.p. motor 400/3/50 supply, together with Pony motor for slow running.

BROADBENT 48-in. HYDRO EXTRACTOR; three-point suspension, galvanised basket and complete with 15 h.p. motor, starting equipment and reverse current braking switch suitable for 400/440 volt 3-phase 50-cycle supply.

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TUNGSTONE ACID PUMPS. A number available in Ebonite, Bronze and Tufnol.

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SPECIAL TANKS

20 ft. by 4 ft. by 2 ft. 8 in., copper open top.

Two Pfaudler Enamel lined, 6 ft. diam.

Eighteen, 30 ft. by 9 ft. welded, dish ended, ½ in. plate.

Iwel steam driven **EXTRACTOR**, 60 lb. pressure.

Six steam **DISINFECTORS**, 7 ft. long, 3 ft. diam.

STEAM BOILERS—400 in stock, new and reconditioned, also **AIR COMPRESSORS, MIXERS, REDUCTION GEARS, PIPES, JACKETED STEAM PANS, etc.**

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VARIOUS MIXERS FOR SALE

No. 200 ONE nearly new **WERNER PFLEIDERER JACKETED MIXER OR INCORPORATOR.** Low type, with C.I. built mixing chamber, 28 in. by 29 in. by 27 in. deep, with double " U "-shaped bottom which is jacketed, and double fish-tail or fin-type agitators geared together at one side, with belt-driven friction pulleys, 34 in. diam. by 5 in. face, with hand-wheel operation and hand-operated screw tilting gear. Machine fitted with machine-cut gears, covers, gear guard, cast-iron baseplate, and measuring overall approximately 7 ft. by 6 ft. by 4 ft. high to the top of the tipping screw.

No. 201 One **DITTO.**

No. 202 One **DITTO.**

No. 203 One **DITTO.**

No 204 One **WERNER PFLEIDERER MIXER OR INCORPORATOR,** similar to the above, with a C.I. built pan 25 in. by 25 in. by 19 in. deep, belt pulleys 26 in. diam. by 5 in. face, double fin-type agitators, and mounted on C.I. legs.

No. 205 One larger **WERNER-TYPE MIXER OR INCORPORATOR,** by Dobson & Barlow, with C.I. built pan or mixing chamber, of the double " U " type, 4 ft. 6 in. by 3 ft. 7 in. by 3 ft. 10 in. deep, with a jacketed bottom and sides to within about 12 in. of top, and fitted with double " Z " type agitators, counterbalanced cover, machine-cut gears at each side, steel back-frame with counterbalancing weights and self-contained belt-driven tipping gear and main triple fast and loose belt pulleys 30 in. diam. by 6¼ in. face, with belt fork. Approximate overall sizes, 12 ft. long by 8 ft. wide by 10 ft. high.

No. 206 One **DITTO** of the same pattern, by **DOBSON & BARLOW**

No. 207 One **DITTO** of the same pattern by **DOBSON & BARLOW**

No. 208 One **DITTO** by **WERNER PFLEIDERER,** with a C.I. built pan or mixing chamber, of the double " U " type, 4 ft. 5 in. long by 3 ft. 8 in. by 33 in. deep, with double " Z " mixing arms, gears at each end, hand-operated tilting gear, with steel backframe, counterbalancing weights and chains, and fast and loose pulleys 3 ft. diam. by 6 in. face.

No. 209 One **HORIZONTAL " U "-SHAPED MIXER,** steel built, riveted, measuring about 8 ft. 3 in. long by 3 ft. wide by 3ft. 3 in. deep, with horizontal shaft, fitted with bolted-on mixing arms about 18 in. long by 4 in. wide, with intermediate breakers, and driven at one end by a pair of spur gears, with countershaft, fast and loose belt pulleys, outer bearing and plug cock type outlet at the opposite end, mounted on two cradles fitted to two R.S.J. running from end to end.

No. 210 One **HORIZONTAL MIXER** as above.

No. 211 One **HORIZONTAL MIXER** as above.

No. 212 One **HORIZONTAL MIXER** as above.

No. 213 One **HORIZONTAL MIXER** as above.

No. 214 One **HORIZONTAL MIXER** as above.

These six " U "-shaped mixers are in some cases fitted with steel plate covers and a steam jacket round the bottom and extending to within about 18 in. of the top with plain end plates.

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Jacketed **VACUUM OVENS** or **DISINFECTORS,** 8 ft. by 5 ft. diam. and 7 ft. by 3 ft. diam. Also various rectangular types in stock.
Twin " Z "-Blade **MIXERS** from ½ to 10 cwt.

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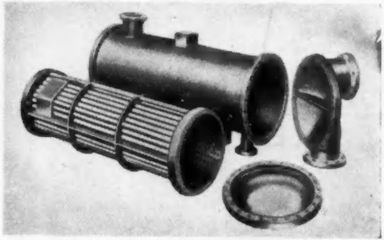

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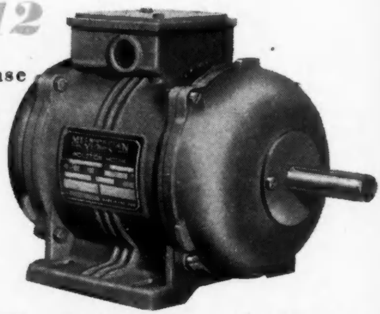

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